

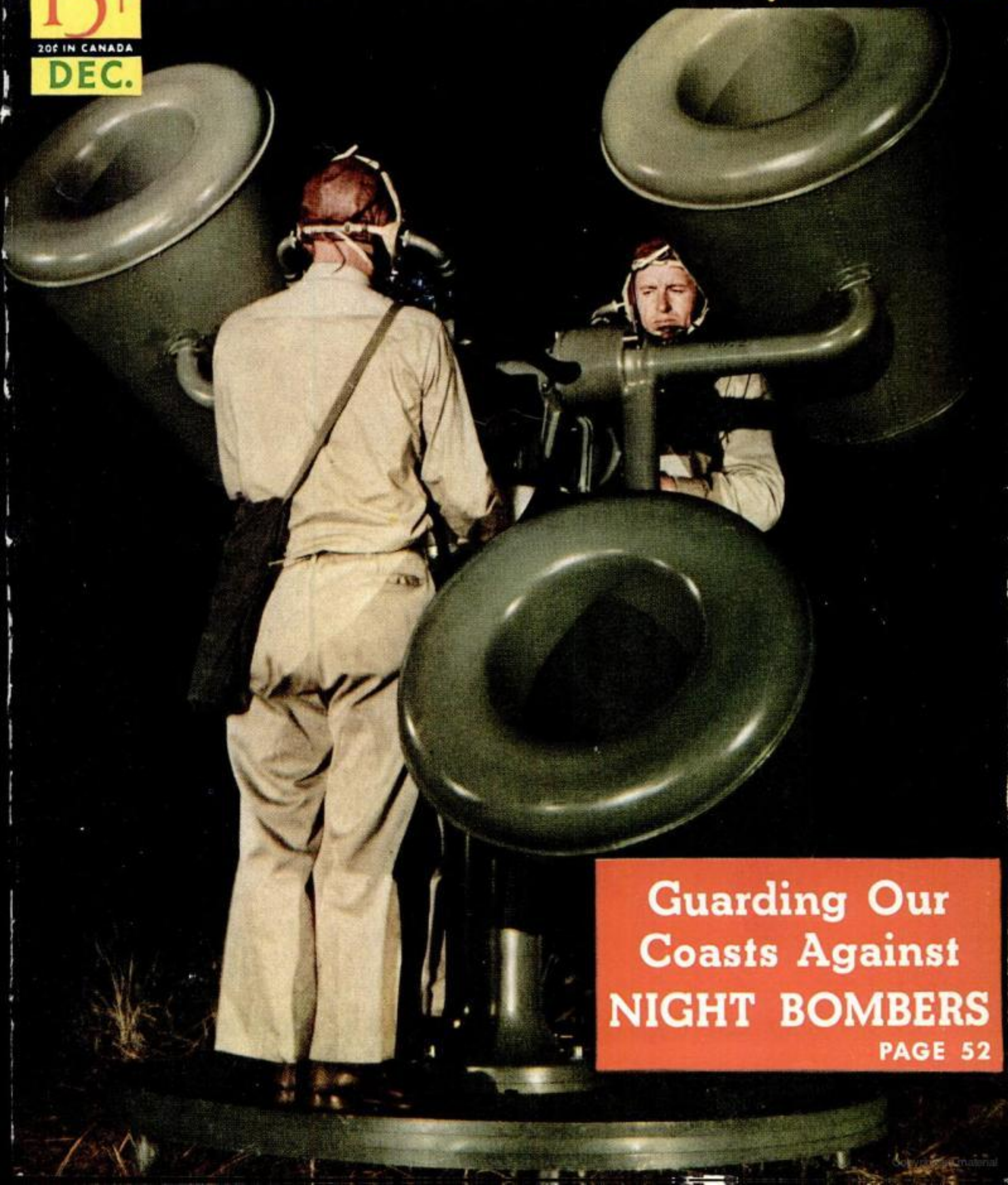
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Tanks Can Be Destroyed

PAGE 75



Guarding Our
Coasts Against
NIGHT BOMBERS

PAGE 52

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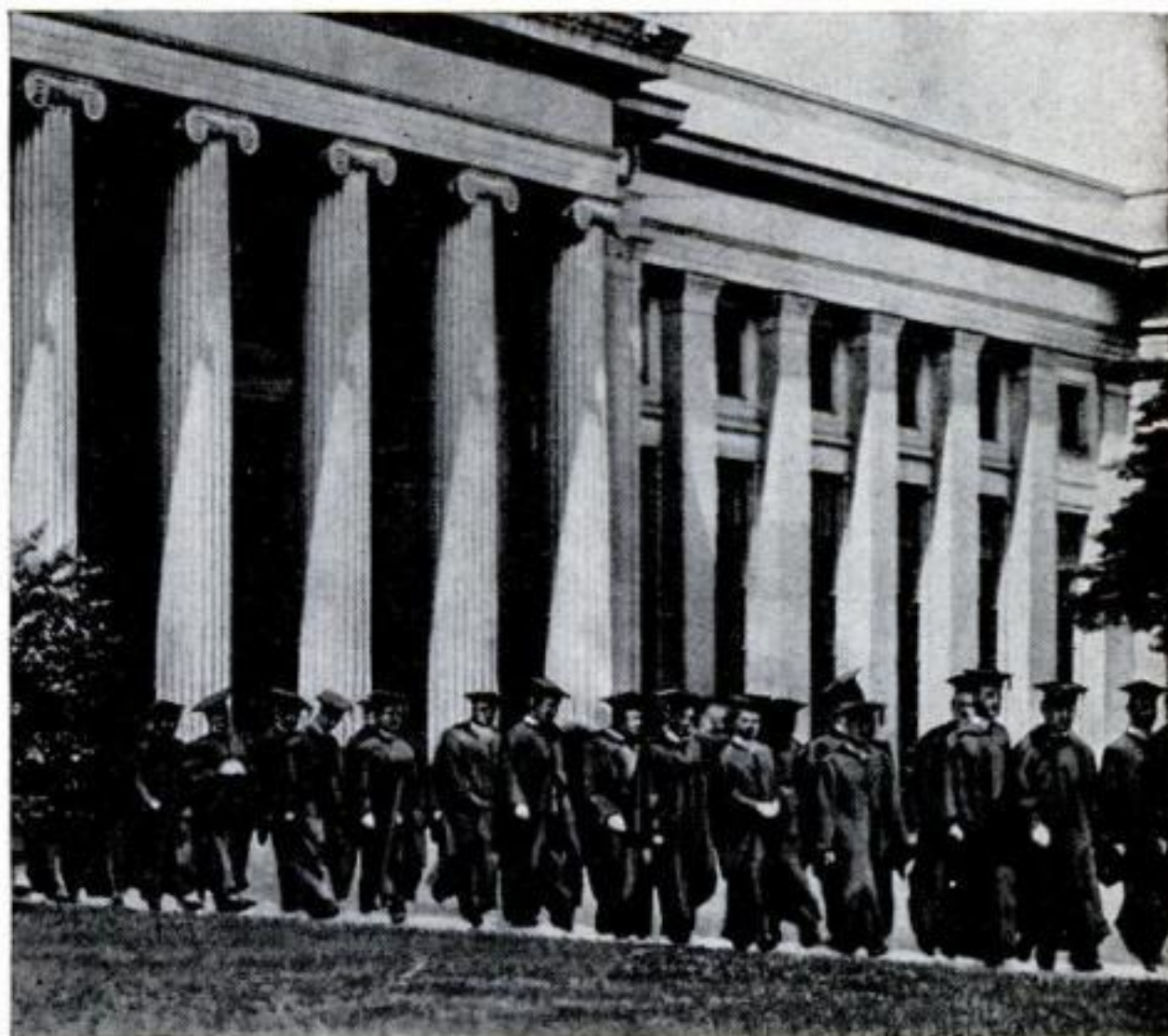
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VOL 139 NO. 6

Mechanics & Handicraft

THE NEWS PICTURE MAGAZINE OF SCIENCE AND INDUSTRY

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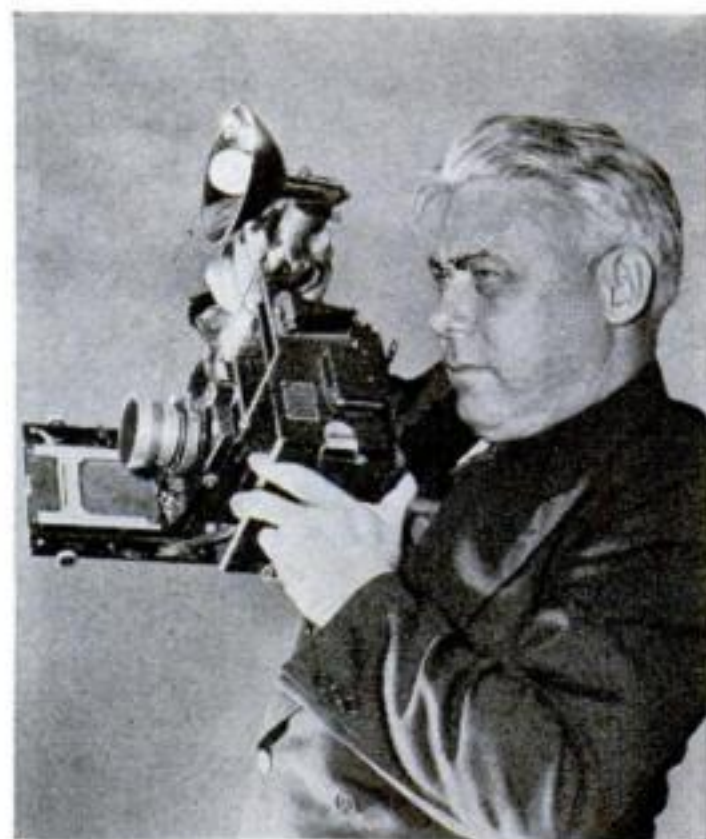
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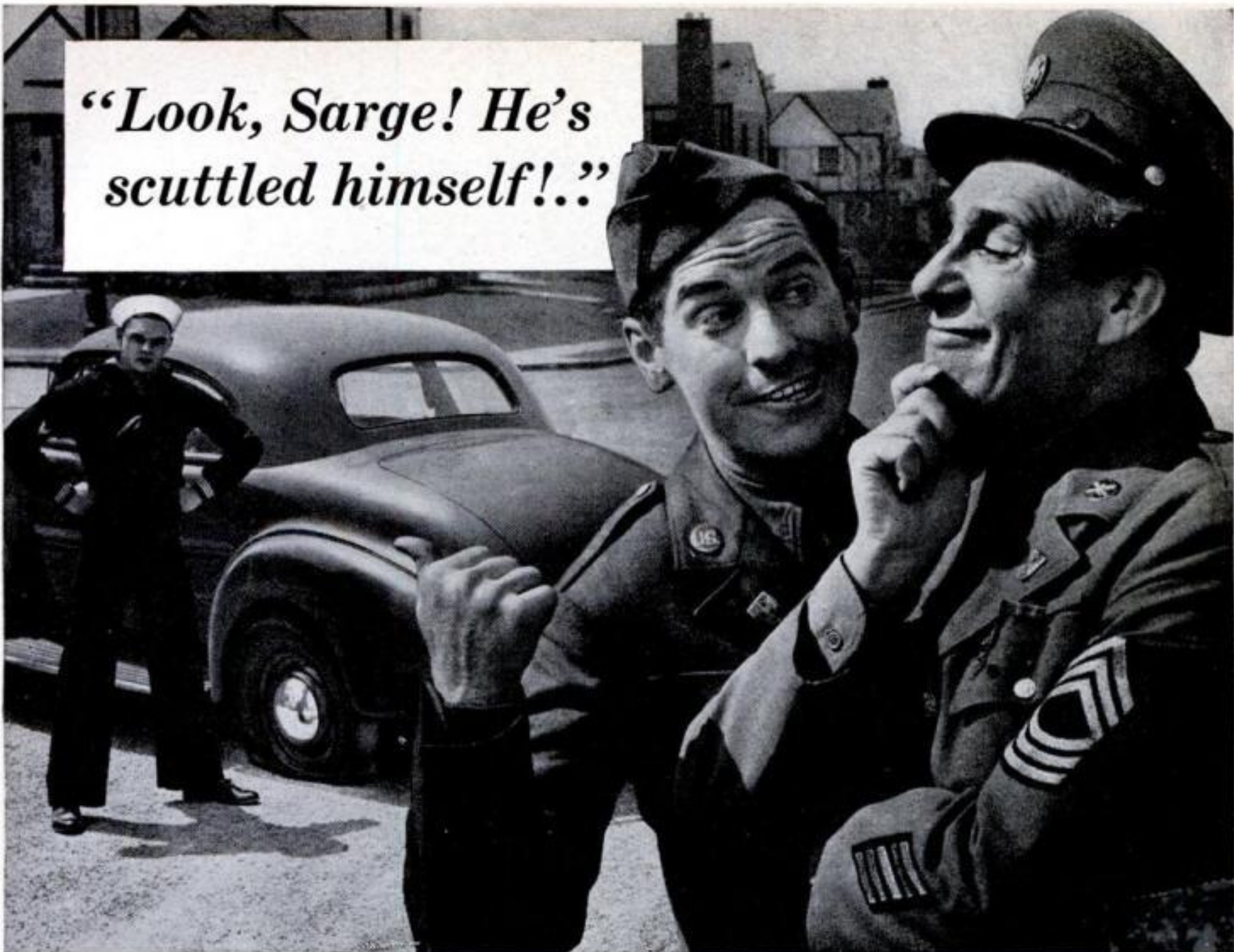


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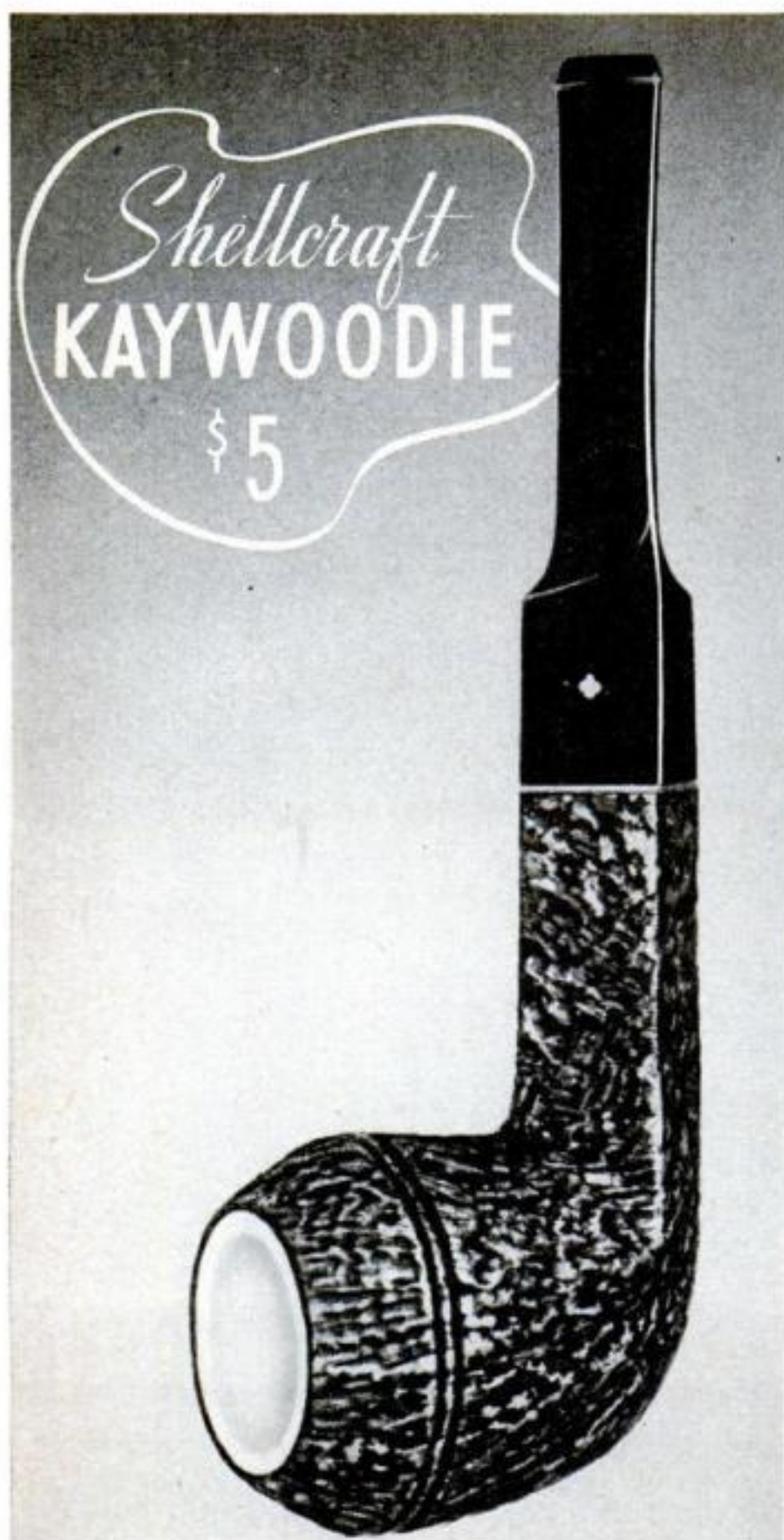


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CADILLAC	8 cyl. J8		10 MM	Y4A	
CHEVROLET	Others 7	Y4A	Y4A	Y4A	
CHRYSLER	J8	J8	J8	J8	Y5
DE SOTO	Reg. Hds. J8	J9	J9		
	Alum. Hi. Hds.	H10			
	Reg. Hds. J8	J9	J9		
	Alum. Hi. Hds.	H10			

MODEL	YEAR				
	'37	'38	'39	'40	'41
DODGE	Reg. Hds. J8	J9	J9		
	Alum. Hi. Hds.	H10			
FORD	Models A & B, C4				
	Big V8 18 MM.	7	7		
	14 mm. H10				
	60 HP H10				
	7 H10				
GRAHAM	Superchgd & 95 Ser. H10				
	H10				
	J10 Com.				

MODEL	YEAR				
	'37	'38	'39	'40	'41
HUDSON	All Reg. Hds.	J9			
HUPP.		7	7	7	7
LAFAY.	7	7	7	7	
LASALLE	J8	J8	Y4A	Y4A	
LINCOLN	7	7	7	H10	H9Com or H10
MERCURY			H10	H10	H9Com or H10
NASH	J8	J8	J8	J9	H9Com
OLDS.	J8	J8	J8	J9	J9
PACKARD	Y4	Y4	Y4	Y4	Y4A

MODEL	YEAR				
	'37	'38	'39	'40	'41
PLYMOUTH	Reg. Hds. J8	J9	J9		
PONTIAC	J8	J8	J8	J9	J9
STUDEBAKER	All Reg. Hds. 8				
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TERRA PLANE	All Reg. Hds. J8				
	Hi. Hds. H10				
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Millions of men are going to work in expanded plants and offices, in new industries. They must have supervision; there will be thousands of new supervisory and executive jobs. Authorities agree that there is a shortage of men for these advanced jobs.

The industries haven't time to train all these executives—they must locate many men already prepared and capable. That means you—if you are ready or will get ready quickly.

These supervisory jobs will be of every kind—office, plant, accounting, traffic, legal, secretarial—they will occur everywhere. They will be in new defense plants, in plants expanded to handle defense orders, and in ordinary product plants (because many men will go from these to the defense plants or into military service).

Obviously, too, this demand will continue and grow for some time to come.

The men who act most quickly will get the most advantage from this unparalleled opportunity. They will be shoved up most quickly and farthest.

LaSalle training fits this situation exactly. It is supervisory, executive training. It is condensed, practical; you study methods and apply them to typical business problems. It is spare-time training—take it as fast as your time permits. You need not wait until you have finished it—what you study tonight, you can use on the job tomorrow. Employers know of LaSalle training—welcome the LaSalle trained men.

You must act quickly. Ask for our 48-page, free booklet on the field in which you are interested. It describes the field, its opportunities and its demands and tells how our training fits you for the field. Send the coupon today.

LASALLE EXTENSION UNIVERSITY A CORRESPONDENCE INSTITUTION Dept. 1283-R CHICAGO

I want to prepare for one of those advanced jobs created by the present situation. As a first step, I must get full information. Please send me your free 48-page booklet on the field I have checked below.

- ☐ Industrial Management
- ☐ Executive Management
- ☐ Traffic Management
- ☐ Business Correspondence

- ☐ Foremanship
- ☐ Salesmanship
- ☐ Business Law
- ☐ Law

- ☐ Accounting
- ☐ Bookkeeping
- ☐ C. P. A. Coaching
- ☐ Business English

Name.....Age.....

Address.....

Present Position.....



KNOWLEDGE
THAT HAS
ENDURED WITH
THE PYRAMIDS

A SECRET METHOD FOR THE MASTERY OF LIFE

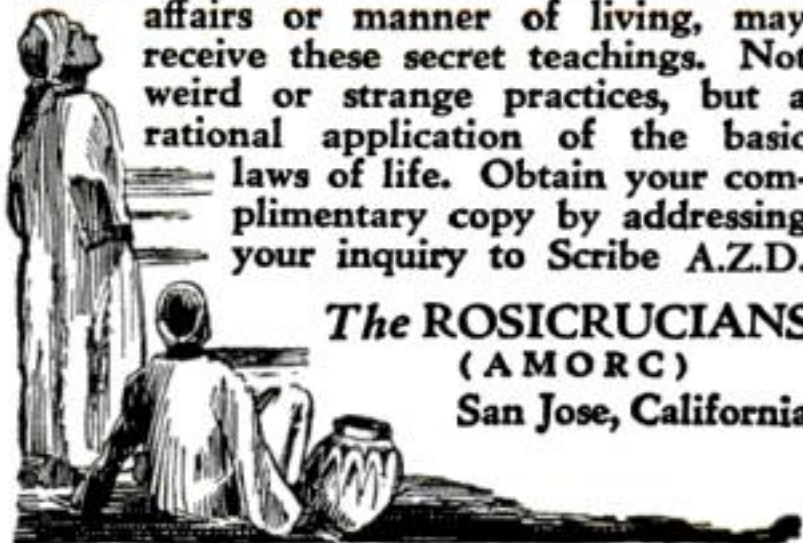
WHENCE came the knowledge that built the Pyramids? Where did the first builders in the Nile Valley acquire their astounding wisdom that started man on his upward climb? Did their knowledge come from a race now submerged beneath the sea? From what concealed source came the wisdom that produced such characters as Amenhotep IV, Leonardo da Vinci, Isaac Newton, and a host of others?

Today it is known that they discovered and used certain *Secret Methods* for the development of their inner power of mind. They truly learned to master life. This secret art of living has been preserved and handed down throughout the ages and today is extended to those who dare use its profound principles to meet and solve the problems of life in these complex times.

This Sealed Book — FREE

Has life brought you that personal satisfaction, the sense of achievement and happiness that you desire? If not, it is your duty to yourself to learn about this rational method of applying natural laws for the mastery of life. To the thoughtful person it is obvious that everyone cannot be entrusted with an intimate knowledge of the mysteries of life, for everyone is not capable of properly using it. But if you are one of those possessed of a true desire to forge ahead and wish to make use of the subtle influences of life, the Rosicrucians (not a religious organization) will send you A Sealed Book of explanation without obligation. This Sealed Book tells how you, in the privacy of your own home, without interference with your personal affairs or manner of living, may receive these secret teachings. Not weird or strange practices, but a rational application of the basic laws of life. Obtain your complimentary copy by addressing your inquiry to Scribe A.Z.D.

The ROSICRUCIANS
(A M O R C)
San Jose, California



Coming Next Month —

DRIVING AT NIGHT is three times as dangerous as driving by day. Statistics show that for every mile you travel after darkness has fallen, your risk of a fatal accident is threefold. In an article based on facts and figures, Myron M. Stearns analyzes the special hazards of night driving and gives common-sense advice for avoiding them. Safety rules and charts enable you to check your own night driving.

NO SOAP—but a chemical cleanser that does lots of things better than soap and some things that soap can't do at all. That's TSP (trisodium phosphate), a white powder that has many important uses in industry. When you read about its amazing powers, you'll want to put it to work in your home, too.

WELDING has been coming into its own lately, with increased use in shipbuilding and many other fields. But nobody has carried it farther than R. G. LeTourneau, inventor and builder of mammoth earth-moving machinery. How this engineering wizard uses welding in his business and private life (even the mantel in his home is welded) makes an interesting story as told by Hickman Powell.

AN SOS FROM AN ARMY CAMP, asking for plans for building recreation-room furniture, is the inspiration of an article by Joseph Aronson, noted interior decorator. His designs for sturdy, easily made settees and tables will be of interest not only to men in camp but also to clubs, outdoor organizations, and owners of game rooms and summer cottages.

SOUPS IN POWDER FORM, vegetables in dry flakes—these are among the new wonders being produced by the dehydration of foods. By removing water, this process reduces bulk and weight, thus cutting transportation costs and offering new convenience to sportsmen and housewives. It also figures in defense and in plans for feeding Europe after the war. Read about it in the January issue.

CASEY JUNIOR is a locomotive—no sleek streamliner, but an engine with a personality. You'll enjoy making him from plans in the January issue, and any kid will enjoy pulling him around on the floor. For good measure, you get plans for circus cars to go with him, and a model of a circus in winter quarters, all resembling "props" in Walt Disney's new feature-length picture "Dumbo."

WANTED

Men Anxious To Make \$30 \$40 \$50 a Week

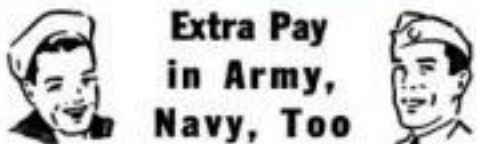


RADIO TECHNICIANS HOLD GOOD JOBS in more than 800 Broadcasting stations in the U. S. with average pay among the country's best paid industries. Aviation, Police, Commercial Radio are other fields which employ Radio Technicians and Operators. I give you the Radio training you need for jobs like these, and train you to be ready when Television opens new jobs in the future. Get the facts. Mail the Coupon.

Busy Radio Industry Increasing Demand For Radio Operators and Technicians

LEARNING RADIO AT HOME NIGHTS THIS WAY HAS LANDED GOOD JOBS FOR HUNDREDS

Here is a quick way to more pay. Radio offers beginners a chance to make \$5, \$10 a week extra in spare time a few months from now, and to train for opportunities paying up to \$30, \$40, \$50 a week for full-time Radio Technicians and Operators. On top of record business, the Radio industry is getting millions of dollars worth of vital defense orders. Many Radio Technicians and Operators have entered military service, opening many opportunities for men with Radio training. Clip the coupon below and mail it. Find out how I have trained men from 16 to 50 years old to make more money in Radio—how I will train you, too, for Radio's opportunities.



Extra Pay in Army, Navy, Too

Every man likely to go into military service, every soldier, sailor, marine, should mail the Coupon Now! Learning Radio helps men get extra rank, extra prestige, more interesting duty at pay up to 6 times a private's base pay. Also prepares for good Radio jobs after service ends. **IT'S SMART TO TRAIN FOR RADIO NOW.** Mail the coupon.



REPAIRING, SERVICING, SELLING home and Auto Radio sets (there are more than 50,000,000 in use) gives good jobs to thousands. Public Address Systems are another source of profit for Radio Technicians. Many Radio Technicians operate their own spare time or full time Radio business. Mail the Coupon.

Beginners Quickly Learn to Earn \$5 to \$10 a Week in Spare Time

Nearly every neighborhood offers opportunities for a good part-time Radio Technician to make extra money fixing Radio sets. I give you special training to show you how to start cashing in on these opportunities early. You get Radio parts and instructions for building test equipment, for conducting experiments that give you valuable practical experience. You also get my modern Professional Radio Servicing Instrument. My fifty-fifty method—half working with Radio parts, half studying my lesson texts—makes learning Radio at home interesting, fascinating, practical.

Mail Coupon for 64-page Book

It tells about my Course; the types of jobs in the different branches of Radio; shows letters from more than 100 men I trained so you can see what they are doing, earning. **Mail the Coupon** in an envelope or paste it on a penny postal.

J. E. Smith, President,
Dept. 1NP3,
National Radio Institute,
Washington, D. C.



N. R. I. Trained These Men At Home



Chief Operator Broadcasting Station

Before I completed your lessons, I obtained my Radio Broadcast Operator's license and immediately joined Station WMPC where I am now Chief Operator.—Hollis F. Hayes, 327 Madison St., Lapeer, Mich.



Now Chief Radio Engineer

I am now Chief Radio Engineer at Kankakee Ordnance Works and very pleased with my new position. If I had not taken the N. R. I. Course I might be digging ditches or perhaps unemployed.—R. S. LEWIS, 410 Whitney St., Joliet, Ill.

\$40 a Month Extra in Spare Time

I do Radio Service work in my spare time only, operating from my home, and I net about \$40 a month. I was able to start servicing Radios 3 months after enrolling with N. R. I.—Wm. J. Chermak, R. No. 1, Box 287, Hopkins, Minn.



Had Own Business 6 Months After Enrolling

I went into business for myself 6 months after enrolling. In my Radio repair shop I do about \$300 worth of business a month. I can't tell you how valuable your Course has been to me.—A. J. Baten, Box 1168, Glade-water, Texas.



FREE TO MEN WHO WANT BETTER JOBS

J. E. SMITH, President, Dept. 1NP3
National Radio Institute
Washington, D. C.

Mail me FREE without obligation, your 64-page book, "Rich Rewards in Radio." (No salesman will call. Write plainly.)

Age.....

Name.....

Address.....

City..... State.....

From the
News Editor's
Desk

KEEPING THE BRAIN COOL while a raging fever surges through the rest of the body has long been a major medical problem. The value of a high fever in the treatment of cancer, for example, is well known, but human beings can rarely withstand body temperatures of more than 108.5 degrees Fahrenheit. Experiments conducted by Dr. Clarence A. Neymann, of Northwestern University, have shown, however, that a dog can withstand very high temperatures if its carotid artery, which supplies blood to the brain, is packed in dry ice. It is hoped that the same procedure may enable humans to receive greater benefits than ever before from fever therapy.

THE THREATENED SHORTAGE of chlorine gas may be averted through a new process reported by two Columbia University scientists, Prof. Arthur W. Hixson and Dr. Alvin H. Tenney. Instead of using large quantities of electric current, as in the process widely used now, the only raw materials needed are sulphur and common salt, both of which are abundantly available. Dry sulphur trioxide is produced by burning sulphur in air. This gas is thoroughly infiltrated through salt. When heated, this material gives off chlorine gas. The solid residue of sodium sulphate is required in the manufacture of glass, rayon, and paper. An economical feature of the new method is that the heat produced by the burning sulphur, in the first step, is more than sufficient to heat the salt cake in the second phase.

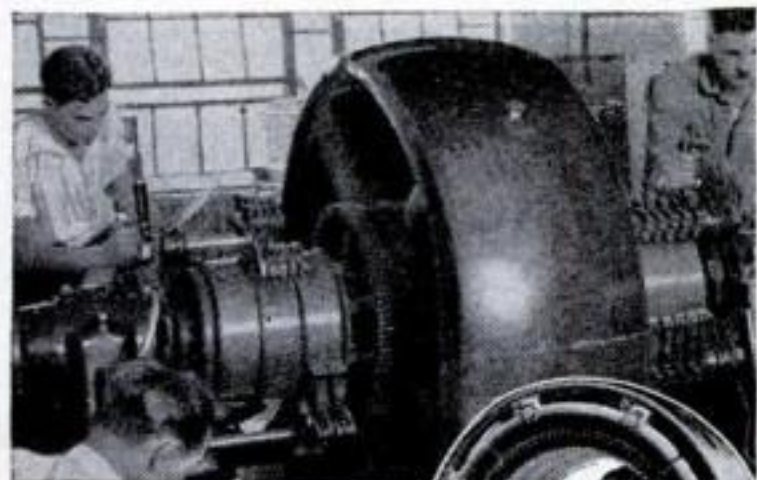
A WORLD RECORD for continuous glass pouring was recently established at the Ford Motor Company's glass plant. For 904 days—almost $2\frac{1}{2}$ years—there had been pouring out a 51-inch strip of glass which, laid in a straight line, would have measured 2,854 miles, or would cover an area of 1,442 acres. The previous record, 159 days, was also established at the Ford plant.

THE U. S. ARMY AIR CORPS has undertaken to measure the qualities that make a first-class fighting pilot before his training is begun. Recognized leaders in psychology, stationed at three new research centers, have already begun the search for this new yardstick which, within limits, will indicate prospective flyers' courage, perception, and judgment.

THE MIRROPHONE, a new magnetic sound recorder and reproducer, is said to handle higher frequencies than previous magnetic sound recorders, and to be freer from distortions. Developed by Bell Telephone Laboratories, it has already proved its worth to singers, public speakers, and instrumentalists for studying speech characteristics and sound production. A record may be kept indefinitely, or cleared immediately for a new reproduction.

AMAZINGLY EASY WAY TO GET INTO ELECTRICITY

I'll Finance Your Training



NO BOOKS NO CLASSES

No dull books, no baffling charts, no classes. You get individual training on real electrical equipment. Coyne training is tested and proven—This school is 42 years old.

EARN WHILE LEARNING

If you need part-time work to help pay your living expenses I'll help you get it. Then, in 12 brief weeks, in the great roaring shops of Coyne, I train you as you never dreamed you could be trained...on one of the greatest outlays of electrical apparatus ever assembled, real dynamos, engines, power plants, autos, switchboards, transmitting stations... everything from doorbells to farm power and lighting... full-sized... in full operation every day!



PREPARE FOR JOBS LIKE THESE

Armature Winder
Sub-Station Operator
Auto & Aviation Ignition
Maintenance Electrician
Service Station Owner
Air Conditioning
Electric Refrigeration
Radio Servicing
and many others

Our Employment Bureau for graduates gives FREE life-time employment service.



H. C. Lewis

**GET YOUR TRAINING
NOW... PAY FOR
IT LATER!**

Don't let lack of money hold you back. If you are between the ages of 16 and 40, you can get this training first and pay for it in 12 monthly payments—beginning 60 days after your training period ends. You'll be amazed at how little money you need to get Coyne training. If you need part-time work to help out with living expenses while you train, my employment department will help you find it. Lifetime employment service after you graduate. Mail coupon for all the facts.

Home of
Coyne
Electrical
School



Learn Without Books in 90 DAYS

Get into the fascinating, fast growing, well paid field of Electricity—a field that offers you opportunities and a future—in good times and bad times—a field that is a permanent necessity in prosperity or depression. Here is your chance to prepare yourself for a lasting permanent future.

Here at Coyne, in 90 days, you can train for your Big Opportunity by working on real electrical machinery. Here you learn airplane ignition, wind armatures, learn power plant operation, do house and factory wiring, etc. Coyne training is **easy to learn**. You "Learn-By-Doing", not by books. Not a correspondence course. You don't need previous experience or advanced education. With this brief description of my school I want to bring out this important fact—you don't need much money to get my training. I have many plans to help the fellow who needs training but hasn't much money. Read all of this advertisement—then mail coupon for all the facts.

MAIL COUPON FOR FREE BOOK

I want to tell you my complete story—how I have helped hundreds of other fellows get good-pay jobs and how I can help you. I want to send you your copy of my Big FREE Book, packed with pictures of students at work in my shops. I want to tell you about my plans to help you. You'll be particularly interested in this special EXTRA offer: **4-Weeks course in RADIO at no extra tuition charge**. Send for my complete story. No obligation. No salesmen will call. Mail coupon today.

H. C. LEWIS, President, COYNE ELECTRICAL SCHOOL
500 S. Paulina St. Dept. 91-73 CHICAGO, ILLINOIS

H. C. Lewis, President,
COYNE ELECTRICAL SCHOOL,
500 S. Paulina St., Dept. 91-73, Chicago, Ill.

Please send me your Big FREE Book and all the facts about Coyne and your plans to help fellows like me get ahead.

NAME.....

ADDRESS.....

CITY.....STATE.....

Readers Say:

He Should Sue Gus Mager for One Scent Damages

IF YOU will look back to the September 1939 issue of your magazine, you will notice in the

Un-Natural History department the statement that a person cannot be scented by a skunk if he holds him by the tail. I can tell you a different story. I had one of these animals by the tail and he scented me and I have three witnesses to prove it. I have been getting your magazine for three years and I

have found only one thing wrong in it. You can guess what.—R. A., Wilton, N. H.



Steam Power for Small Boats Suggested as Defense Step

IN VIEW of the recent gasoline-shortage scare on the eastern seaboard, and the hints that the scare may become more real in the near future, why don't you do something to develop an interest in the use of steam as a power source for small boats? I own a small 18-footer inboard not dissimilar to some you have featured. It is a fairly common craft. While I am overpowered, ten horsepower usually is ample for this kind of boat. A coal, coke, or wood-fired boiler and a small single or two-cylinder steam engine ought to drive her adequately. But there has been no information on steam engines for many years. What has happened to the old Stanley Steamers, the Doble-Detroits, the White Steamers? Their engines might be available somewhere. And boilers—maybe they could be built as flash boilers using alcohol under pressure or

HOT DIGGETY!



something similar. Boats have their defense uses, but gasoline is limited. P. S. M. could be doing a patriotic act in awakening the boating fraternity to the older methods of propulsion.—E. T. S., Washington, D. C.

The Movie Projectionist—as Seen from the Audience

THAT was an interesting letter by J. A. W., telling how movie projectionists pass the time by watching for technical flaws in the picture. However, I don't believe that many of them pay much attention to the screen. Sitting in the audience, I notice that they can beat any Hollywood film editor in making mistakes—which mostly result from the operator's not watching the screen. Here are a few of the mistakes I have seen in my 16 years of movie-going (I am 16): At the start of the show, the sound track pops on and runs for a long time before the lights go out (if they do at all). Then the newsreel is slid on with the picture cut in half; the operator hears violent whistling, looks out the window, and centers the film correctly. At the change-over, he turns the second projector on too late and we are treated to about a half minute of labels and titles that the audience is not supposed to see. About the middle of the feature, one machine gets out of focus and as a result we watch alternate bad and good reels for the rest of the program.—G. B., Riffle, W. Va.



Paraffin Fixes Leaky Windows as Well as Battery Terminals

NOTICED in Readers Say that somebody suggested candle wax for keeping car-battery terminals from corroding. My husband has used heavy grease for several years and it is most satisfactory. Smear on plenty of it. I have another true and tried suggestion: If a window stubbornly leaks, pour melted paraffin in all the cracks around it. One side of our house trailer leaked water in on my clothes because the sun had caused it to bulge and pull away from the wooden strip it was attached to. I filled the crack with paraffin and now all is O.K.—Mrs. C. W. L., Delaware, Ohio.

**THEY WHISTLE
THEY'RE ALL-ELECTRIC**

Built with No. 8½
Erector Set


Built with No. 9½
Erector Set



THEY 'BUZZ' WITH ACTION

**The COLOSSAL
ALL-ELECTRIC ERECTOR**

P. S. When in New York City, visit the Gilbert Hall of Science, Fifth Avenue at 25th Street, and see the complete exhibit of Erector, American Flyer Trains, Gilbert Chemistry Sets and other Gilbert Scientific Toys.



**ALL-ELECTRIC
NO. 8½ ERECTOR**

Crammed with exciting electric features. Whistle. 110 Volt reversing electric engine, with automobile-type gear shift. Electric lights. Electro-magnet so powerful it grabs up steel girders before it touches them. Contains total of 15 pounds of up-to-the-minute parts for building bascule bridge, giant Ferris wheel, magnetic crane, oil drilling rig and many other whistling, engine driven, electrically lighted engineering marvels. Builds over 100 models.



HELLO BOYS! Look at all the fun and action you get with my new Erectors

It's colossal, boys . . . that towering Erector army training parachute jump. You build it yourself. Piece by piece—with your own hands—you fit the long gleaming girders together—attach the rigging for the four parachutes—and install the powerful Erector reversing electric engine . . . And now for thrilling fun. Give the action signal by blowing the Erector whistle . . . throw your engine into gear and your parachutes are hoisted up and up until they strike the release mechanism. Then, like a flash they plummet downward—unfold—and lazily float to the ground.

Now get a load of that mighty Ferris wheel. It whistles—twinkles with light—operates in either direction at slow or high speed.

You can build hundreds of spectacular, realistic mechanical marvels with one Erector set. And how the Erector electric engine makes them buzz with action! See my new All-Electric Erectors at your nearest toy store today. Take Dad along. A. C. Gilbert, President.



—big 24-page illustrated book, "Fun and Action for Boy Engineers."

Boys, getting this book is as exciting as going to the movies. Over 100 illustrations showing all of the new Erector sets and the gigantic, realistic action models they build. Mail coupon or post card.

The A. C. Gilbert Co., 601 Erector Square
New Haven, Conn.
Here's my name and address. Rush big book.

Name.....

Street.....

City.....State.....
Offer good only in U.S.A.

**STALLING ALL CARS! CLEAN OUT
RADIATORS WITH SANI-FLUSH
BEFORE ADDING ANTI-FREEZE**



A clogged radiator causes overheating. Wastes anti-freeze. Often causes expensive trouble. Don't take chances. Sani-Flush cleans out automobile radiators for 10c. (25c for the largest truck or tractor.)

Do the job yourself—or have your service station do it. Plain water isn't enough. Insist on Sani-Flush. Can't harm aluminum cylinder heads. It's used in most bathrooms for cleaning toilet bowls. (Directions on can.) Sold by grocery, drug, hardware and 5-and-10c stores. 10c and 25c sizes. The Hygienic Products Co., Canton, Ohio.

Sani-Flush
CLEANS OUT RADIATORS

Readers Say:

Remember Now, Fellows— Only OLD Alarm Clocks!

E. J., OF BROOKLYN, N. Y., wants to know what to do with broken alarm clocks. For ten years (since the age of six), I've been taking apart old alarm clocks and have put them to good use in at least four or five different ways. If you have a youngster in the house, he would be tickled if you made him a present of the delicately balanced pendulum wheel for a spinner—or, if you wish, you can make him a small gyroscope with it. The hairspring attached to it should be removed carefully and saved, for there are many times around the shop when its delicate tension comes in handy. The gear ratios provided by the time and alarm mechanisms are also very useful. For instance, at present I am building a model three-way derrick, using two toy building-set motors and the gear mechanism from a large alarm clock. The alarm mechanism is used to gear down the control for the block and tackle, and the time mechanism gears down the control for lifting and lowering the crane. (The swivel is operated by a worm gear from the building set.) This use of course necessitates the removal of the heavy springs, which are useful for heavy-tension jobs around the shop. Now will someone please suggest a simple way of getting a dozen separate electrical contacts into a swiveling cab whose turning diameter is six inches?—J. W. W., New York City.



Lots of Things Can Cause Excessive Oil Use

THE average motorist thinks of a ring job when oil use becomes excessive. However, defective rings are only one of many causes of engine-oil waste. I wish you would have an article in your magazine about this soon.—O.B., Boston, Mass.

O.B. may find something of interest on page 130.

TOO MUCH OIL DOES
MEAN A RING JOB!



**BIG MONEY Assembling
NEW MEAD KI-YAK**

at Home!

MEAD'S complete cut-to-fit KI-YAK Kite easily assembled for pleasure

WRITE
for big
illustrated
FREE
Circulars!

MEAD GLIDERS, 15 S. Market, Dept. D-121, Chicago

or profit! Portable, Seaworthy . . . Light . . . Fast. Highest quality. Low cost. 3 models 20 lbs. to 45 open a new world of sport for you both in sailing, paddling. Also 2 portable Outboard Models. Finished double-blade paddle or Oars now INCLUDED with your KI-YAK. Write now for illustrated circulars, low Factory-to-You prices!

America Can't Wait Industry needs you NOW

Defense Program Needs Trained Men

There is a tremendous shortage of skilled men in almost all branches of industry. Draftsmen, electricians, machine designers, machinists, are wanted for good jobs at fine pay. Executives too; foremen, superintendents, managers, are needed right now to handle the enormous demand for finished products of all kinds. If you are already in one of these fields, you owe it to your country, to your family, and to yourself to make yourself even more valuable, to climb and climb fast and help put through the most important program we have ever had to face.

Opportunities Everywhere

Home building, ship building, manufacturing plants, great utility projects, road building—everywhere you look you find a demand for men—not just ordinary workers, but men who know more than their fellows, who are better at their jobs, who know both theory and practice and can therefore train other men, thus rising to more and more important stations and being of greater and greater help. Practically every industry is included in those needing MEN, trained men, skilled men, men with ambition and punch.

Learn at Home

Over 40 years ago we developed a system of home study which has helped thousands of men to important positions in the mechanical and business world. Those of you who have missed college training, who haven't the time to go away to school, who must LEARN AS THEY EARN, can get education in your particular field—yes, education of college grade right in your own home. Best of all, you can study when you have the time, and above everything else you will have the commendation and the respect of your employers in doing so. Rest assured that every superintendent, every factory manager, every general manager will have his eye on the man who pushes forward, who recognizes the great need of the day, and who has made up his mind to be one of the first to make good.

Business Welcomes Applications from American School Advanced Students and Graduates

Whenever trained men have been badly needed, business has been quick to say, "We welcome applications from American School advanced students and graduates." We maintain an employment placement service to help put you in touch with the best openings, and we make no extra charge of any kind for this service. Write now for an outline of home study training courses; check the coupon indicating your preference and mail it promptly.

AMERICAN SCHOOL

Dept. G946, Drexel at 58th, Chicago

Rich Rewards

In bidding for skilled men now, industry of all kinds, everywhere in the United States is offering top pay. They want the best men and they are willing to pay for their services. But remember this, you not only have opportunities for bigger pay than you probably ever hoped for, but the chances for advancement are even greater. Foremen, superintendents, factory managers, must be drawn from the ranks, and surely you know that the man who studies, who tries to know everything there is to know about his job will be picked first. Best of all, under the present training program, with the tremendous need for skilled men you don't have to look too far in the future for:

**Results
Come
Quickly**

Get the Facts

(No Cost) All you have to do to find out about this type of training, to get the details and the outline of study, with histories of the successes of other men, is to write us or send the coupon. There is no cost and no obligation of any kind. Let this great school, one of the pioneers in the home study field, explain the methods which can do so much for you. Get this information now so that you can make up your mind quickly to get started on the road to the fulfillment of a real ambition, and so that you may be of the greatest possible help in this present emergency.

Mark, Clip and Mail This Coupon NOW!

AMERICAN SCHOOL, Dept. G946, Drexel at 58th, Chicago

Without obligation, Please send FREE and postpaid, bulletin and details of the Subjects checked.

- | | | |
|---|---|---|
| <input type="checkbox"/> Air Conditioning | <input type="checkbox"/> Retail Merchandising | <input type="checkbox"/> Drafting and Design |
| <input type="checkbox"/> Elec. & Gas Refrigeration | <input type="checkbox"/> Cost Accounting | <input type="checkbox"/> Radio and Television |
| <input type="checkbox"/> Architecture and Building | <input type="checkbox"/> Practical Bookkeeping | <input type="checkbox"/> High School |
| <input type="checkbox"/> Plumbing and Steam Fitting | <input type="checkbox"/> Economics of Direct Selling | <input type="checkbox"/> Home Economics Courses |
| <input type="checkbox"/> Automotive Engineering | <input type="checkbox"/> Private Secretary | <input type="checkbox"/> Business Law |
| <input type="checkbox"/> Aviation Drafting | <input type="checkbox"/> Diesel Engineering | <input type="checkbox"/> Liberal Arts |
| <input type="checkbox"/> Aviation Engineering | <input type="checkbox"/> Surveying & Topographical Drafting | <input type="checkbox"/> Mechanical Engineering |
| <input type="checkbox"/> Business Management | <input type="checkbox"/> Sheet Metal Pattern Drafting | <input type="checkbox"/> Shop Management |
| <input type="checkbox"/> Accounting and C.P.A. | <input type="checkbox"/> Electrical Engineering | <input type="checkbox"/> Tool Making |
| <input type="checkbox"/> Salesmanship | | <input type="checkbox"/> Better Foremanship |
| | | <input type="checkbox"/> Engine and Boiler Work |

Name.....Occupation.....

Address.....Age.....

City.....State.....

MONEY MAKING OPPORTUNITIES

R. E. BRANDEL, Editor

They Keep On Earning Money by Easy Electroplating



THE MAN who dreams of earning extra money, as much as \$50 or \$60 per week, need not dream in vain. Brush electroplating offers that opportunity. Here's what Jasper Brown of Chicago says: "I bought my electroplater to experiment with during my spare time. In a few evenings I

earned the cost of the machine by plating jewelry, silverware, headlight reflectors, etc., for friends and neighbors. Now I have all I can do. I recommend this machine to all who want a profitable business."

Jasper Brown is headed for a business of his own, apparently. Restaurants, music stores, doctors, dentists and garages are only a few of the many sources of business for the electroplater who wants to hear more cash jingling in his pocket.

J. J. Wilson, Slidell, La., writes: "After I received my electroplater I practiced for about an hour. I made up four samples and went out after business. One of the large chain restaurants now has me do all their silverware."

Max Hemmert, Idaho Falls, Idaho, states: "I am now spending all my time in plating work. I purchased a brush plater last summer and have worked up a very promising business."

Frank Welde, Philadelphia, goes after garage business. He writes: "I electroplated a few brass strips for samples. I then showed these strips to different people and that's how I got plenty of jobs. I have all the work from a big garage. The owner gets 10% of what is charged his customers, and the rest goes to me for my work."

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AIN'T FISH JUICY ENOUGH?



and then. I always look for any notes on fish, and was thrilled when I read the letter of F. C. H., of Boulder, Colo., about his garden pool. I have an indoor set-up, but am experimenting on the line of keeping goldfish dormant for a few months at a time. Perhaps some other readers have some ideas along this

line.—H. O., Stamford, Conn.

Next We'll Have to Do It with Just Half a Tube

JUST a line to let you know that I built the "Europe on One Tube" radio described in your April 1940 issue and it really hops the ocean. I can get London or Berlin any night. Just a suggestion, though: If the fixed .01 condenser in the antenna is changed to a variable 15 to 30 mmfd., the set will tune much better. Each month the radio section is the first I turn to. Let's have more A. C. short-wave sets.—J. R. (W8SWL), Huntington, W. Va.

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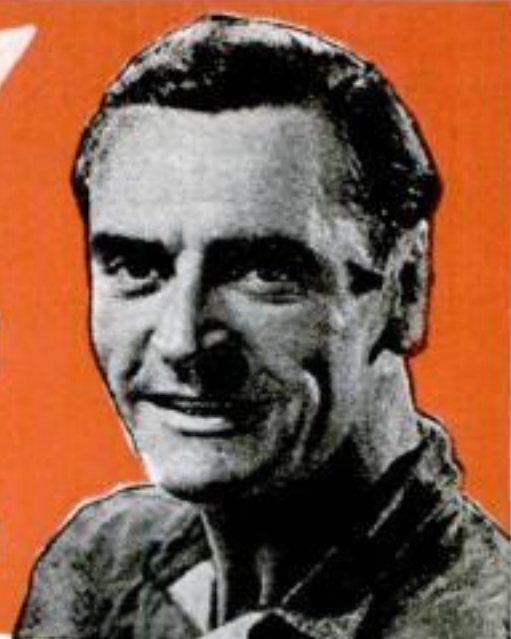
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not think it right to make a claim for back numbers of the magazine, in view of the more valuable cargoes plowing their dangerous ways over seas fraught with peril and under skies equally menacing. So we'll say nothing of numbers missed and be thankful to get any at all.—Capt. E. L. F., London, England.

INVENTORS!

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THE AMAZING SUCCESS STORY OF A. L. M. (name on request) TOLD HERE IN HIS OWN WORDS

"I AM glad to tell the story of how I got started on the road to my present success, because I feel certain that it will be of real interest and possible inspiration to other inventors who are just starting out.

While attending a technical school I became very much annoyed with the inadequacy of one of the tools required in the course of my study. As a result I conceived an idea for an improvement which I felt so surpassed the tool then used, that I was certain other students and professional men would find it very valuable. I demonstrated it to my friends and they were so greatly impressed with its commercial possibilities, that they advised me to get a patent on it.

Acting immediately upon this suggestion, I wrote to Clarence A. O'Brien, having been advised that he was a reliable and competent registered patent attorney. Following prompt instructions from Clarence A. O'Brien, I submitted my invention to him for the purpose of making a preliminary patentability search of the Patent Office records. The good word soon came back . . . my invention appeared to be patentable! I believe that this was one of the greatest moments of my life. Armed with this assurance, I promptly filed application for a patent. As soon as the patent was thus pending, I was in a position to commence volume production of my invention. I then arranged an interview with one of the largest manufacturers in the business, and demonstrated the model to him, since in the meantime

Clarence A. O'Brien had secured the necessary patent for my invention. The manufacturer was so favorably impressed, that he gave me a substantial order. He was so pleased with the sales results of my invention that he is now reordering in great quantities. Other manufacturers caught up the idea, and today I am supplying most of the market, and am protected against infringement by the patent obtained through the efforts of Clarence A. O'Brien.

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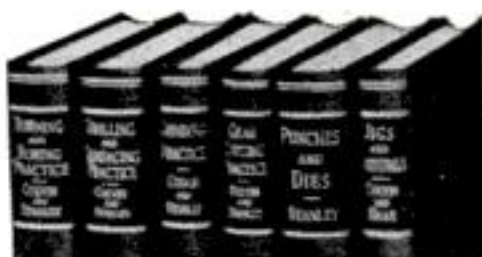
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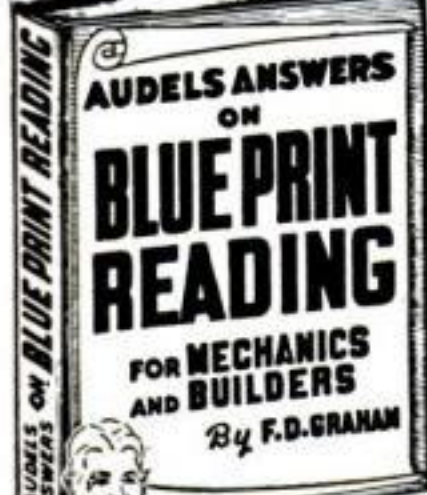
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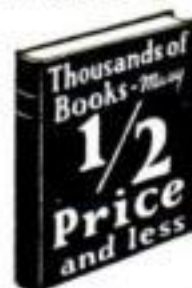
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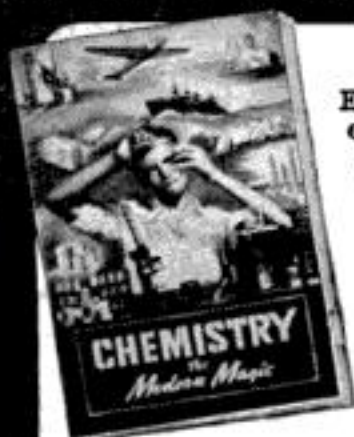
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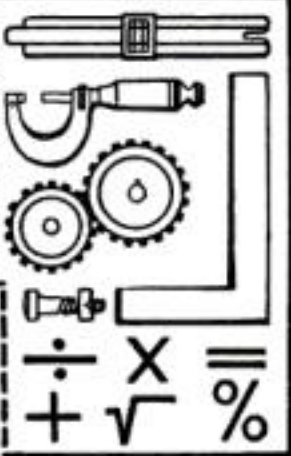


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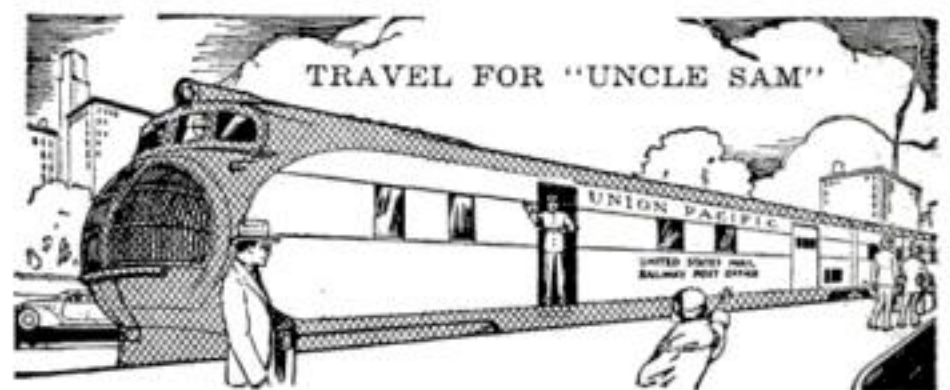


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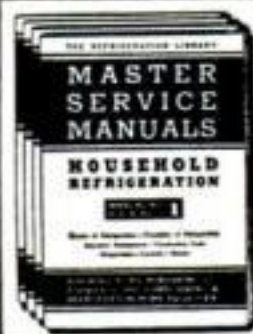
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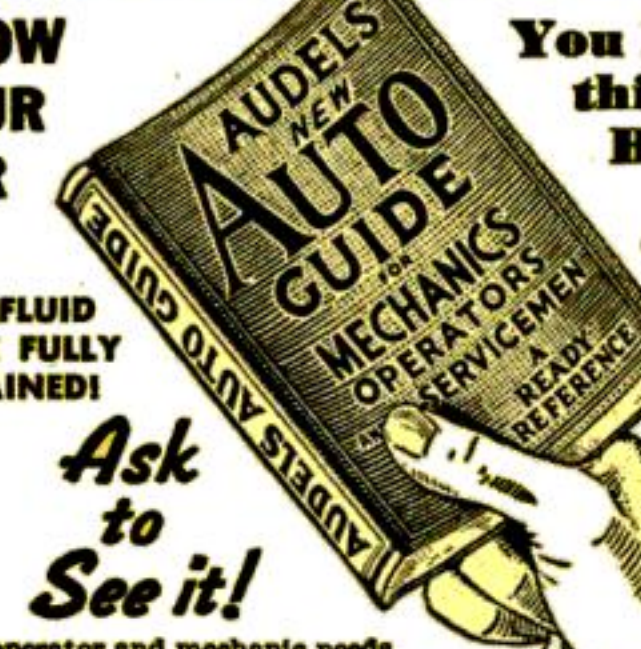
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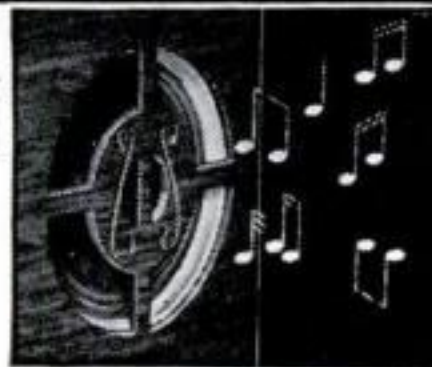
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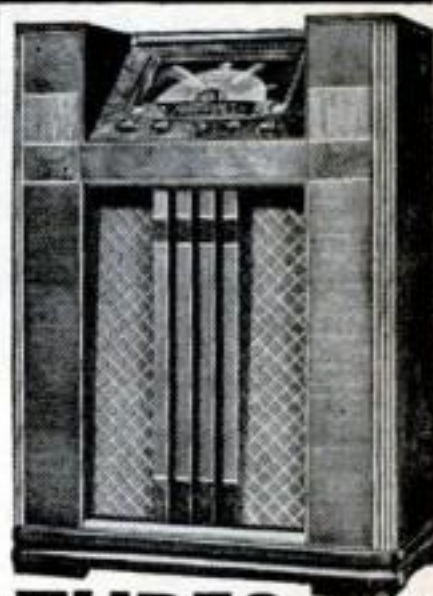
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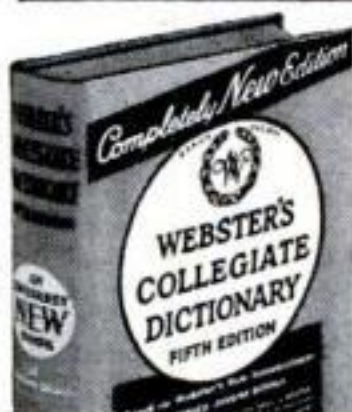
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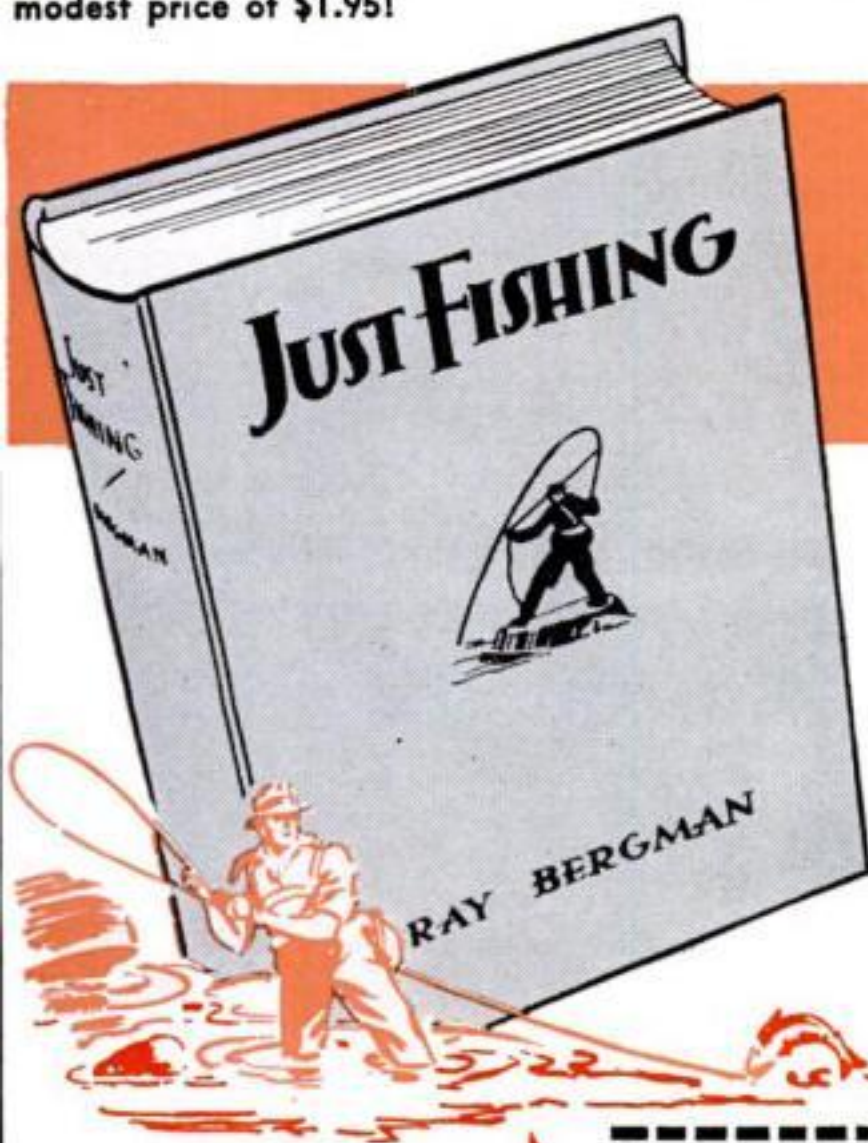
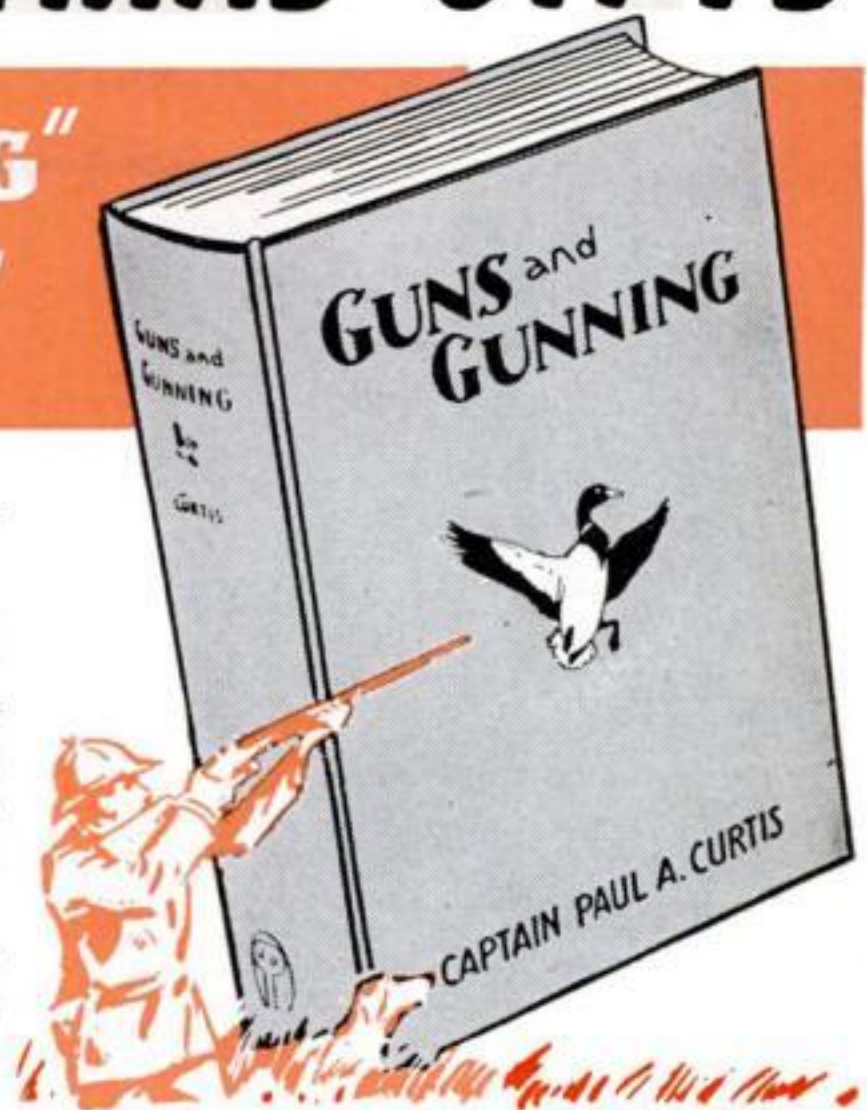
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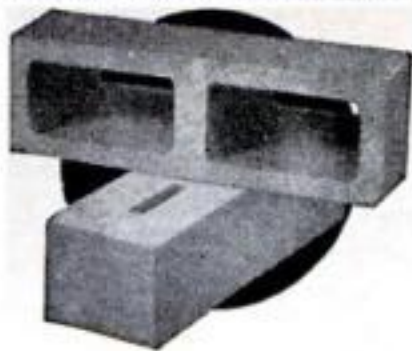
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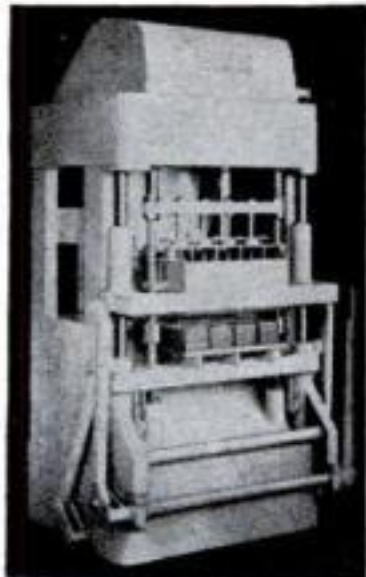


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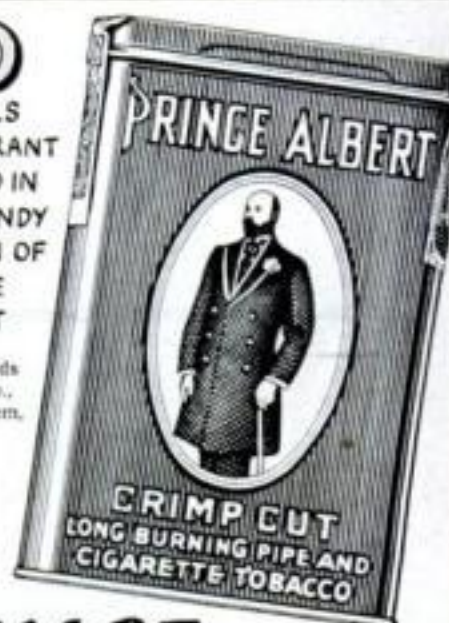
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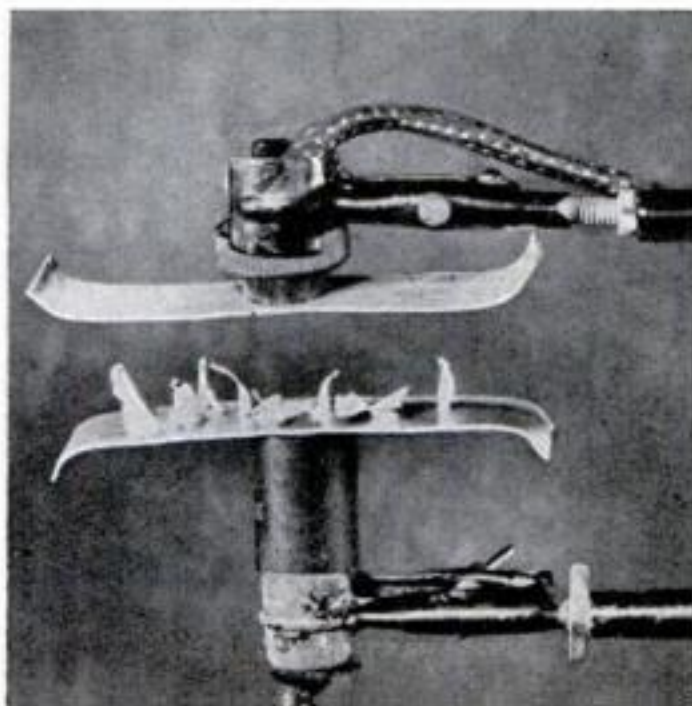
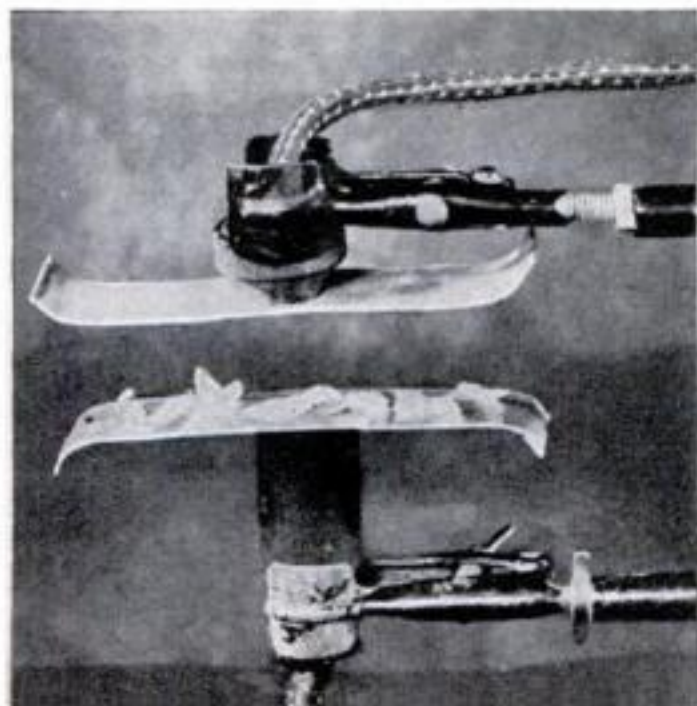
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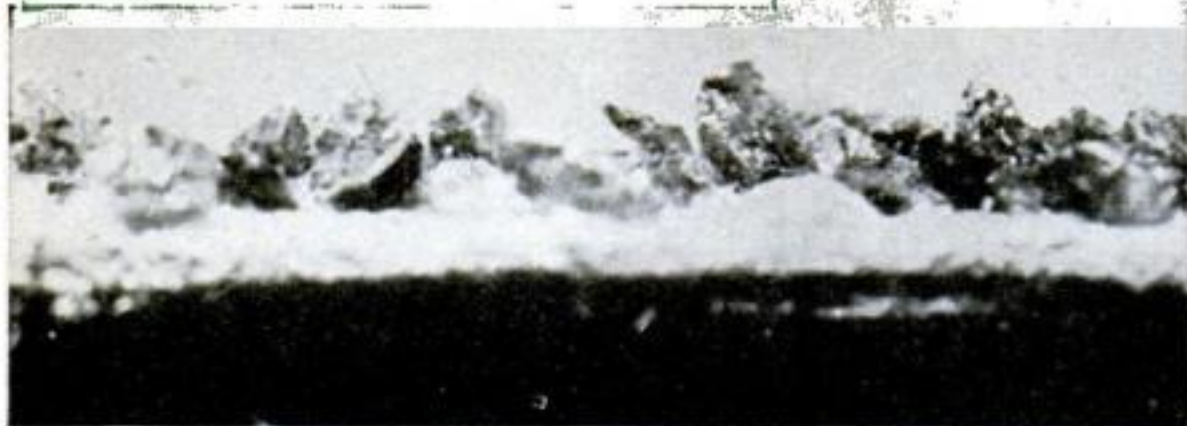
HARNESSING the electric force which crackles through your radio as static and makes your cat's hair stand on end, scientists have created revolutionary new sandpapers, long-wearing upholstery velvets, and dainty dress fabrics decorated with high-pile, embroiderylike designs.

Long-wearing and fast-cutting electro-coated sandpaper now constitutes a third of the output of four of the largest coated-abrasive makers of the country. It is a vital tool in helping speed industrial production. Millions of yards of "electro-broidered" dress materials have been sold. Upholstery

JUMPING BITS OF PAPER illustrate the principle in making both the abrasive and dotted swiss at the top of the page. In the photos below, the lower electrode is connected to a high-voltage terminal, and the upper grounded. Current off, at left, the papers lie flat; on, they stand erect, then jump up



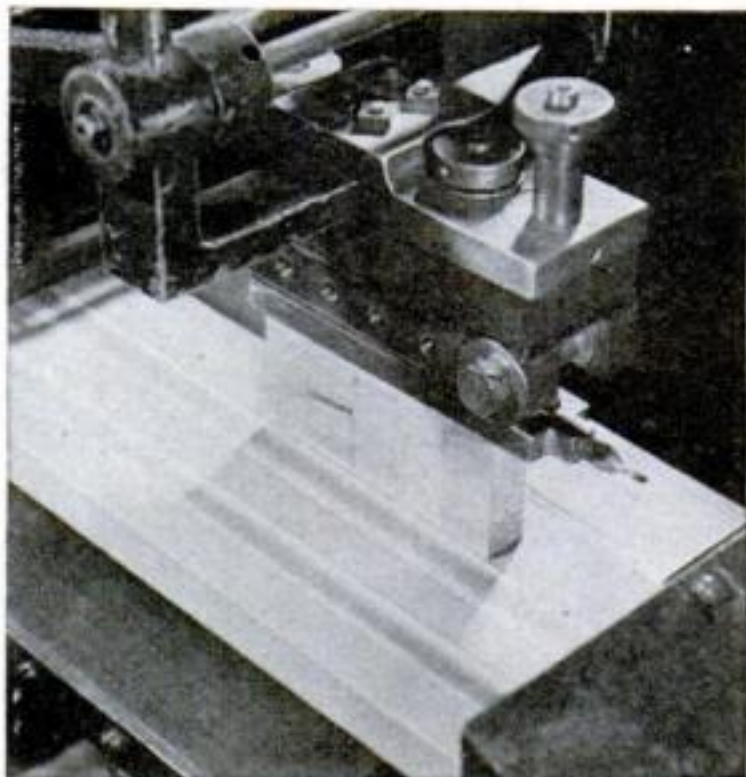
Regular Process



Electro-Coating Process



PHOTOMICROGRAPHS at left show a cross section of ordinary gravity-coated sandpaper and of electro-coated paper. Note how erect grains are on the latter. The machine below tests cutting



velvets are not yet available commercially, but tests show them to be as much as three times as wear-resistant as woven velvets.

Oddly enough, the principle involved dates to man's first knowledge of electricity. Thales, a Greek philosopher of 600 B.C., knew that rubbing a piece of amber would cause bits of straw or feathers to stand on end and jump to it. After 2,500 years, E. C. Schacht, of the Behr-Manning Corp., Troy, N. Y., one of the largest sandpaper makers in the world, conceived the idea of using static electrical force to make a better sandpaper on which all grains would stand on end.

Here is how it works: The abrasive grains are dropped onto a belt which carries them between two electrodes connected to a rectifier or a transformer. An adhesive backing is passed beneath the upper electrode. Entering the electric field, the grains first stand upright, then are repelled from the

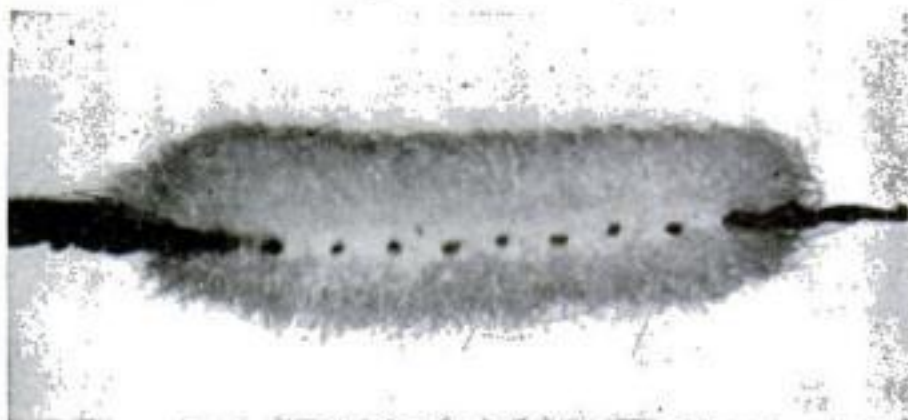
lower electrode and shot upward to the adhesive backing, where, all being charged, they repel each other, spacing themselves uniformly. Cutting was improved from 20 to 50 percent.

Today, electro-coated abrasives are found on many big metal and woodworking jobs. Coated with aluminum oxide and silicon carbide, the hardest abrasive grains, they are sold under the brands of Lightning, Electro-Coated, and Elec-Tro-Cut. For precision, abrasives, backings, adhesives, and the coating process are under constant watch. At the Behr-Manning plant, forty engineers and chemists maintain the check.

Abrasives, received in lumps, are crushed to grit and screened in grain sizes ranging from those that pass through a mesh of 12 to the inch to specks about $1/2,500$ inch across. The finest screened size, No. 240, goes through a mesh with 57,000 openings



ELECTRO-BROIDERY on dress goods, at left, is an example of the high-pile designs made possible through the use of static. Below, a cross section of one of the electro-coated dots. The fibers go right through the fabric



to a square inch. Still finer grains are prepared by water classification or by air flotation, taking advantage of the fact that coarser grains settle more rapidly in either water or air than the finer grains.

Paper backing is made from rope, wood pulp, or jute in several weights. Jean or drill cloth backs are used where operations require more strength or flexibility. Both must pass rigid tests. The adhesive is a special hide glue or a synthetic resin.

The paper or cloth is fed into the "making" machine, which may carry a run of 100,000 yards or 60 miles, without a stop. Adhesive is applied, and the grains are shot into it through the electrostatic field. The material then goes to drying racks, getting there an anchor coat of glue. After final drying, it is wound into rolls.

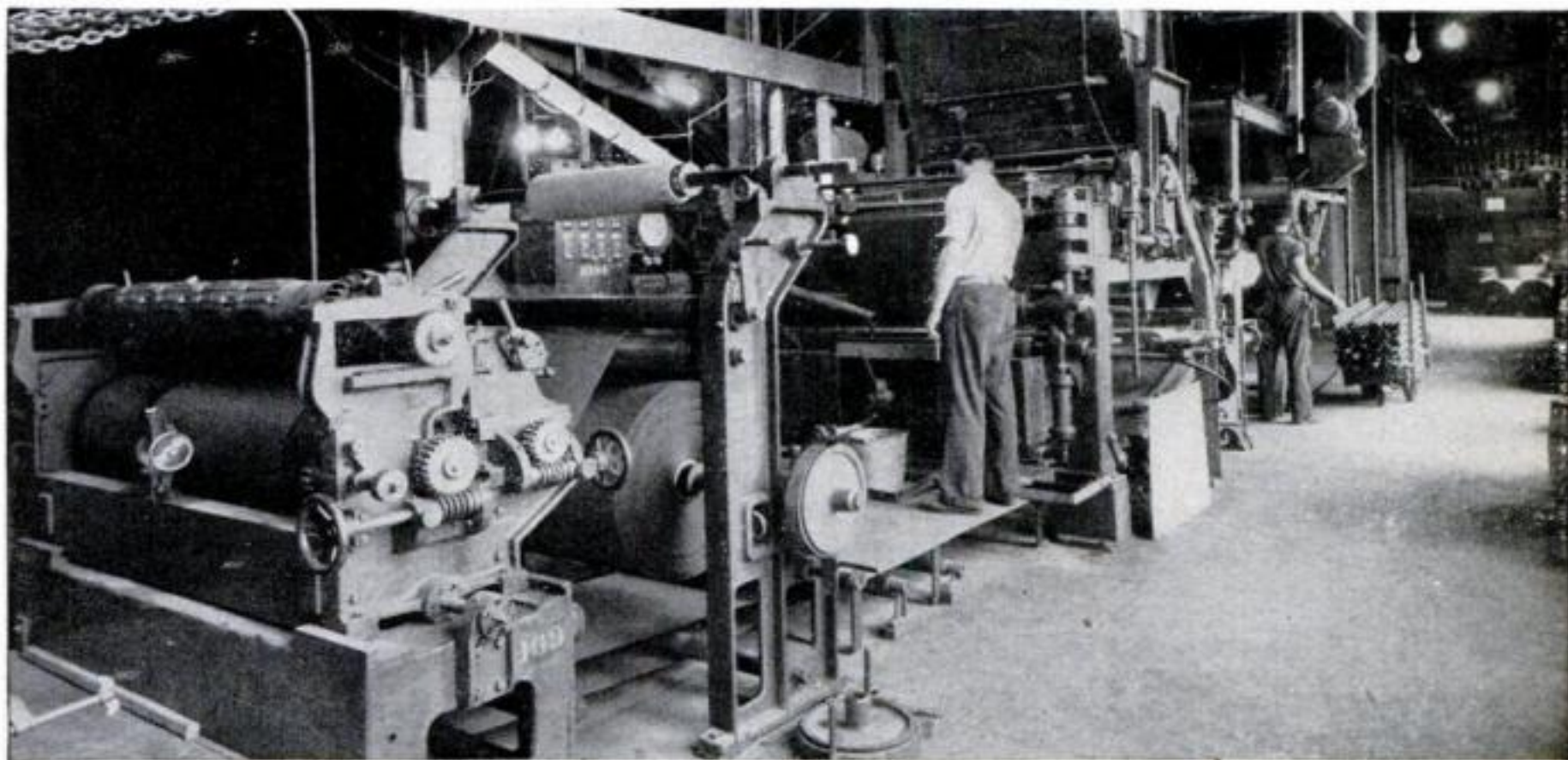
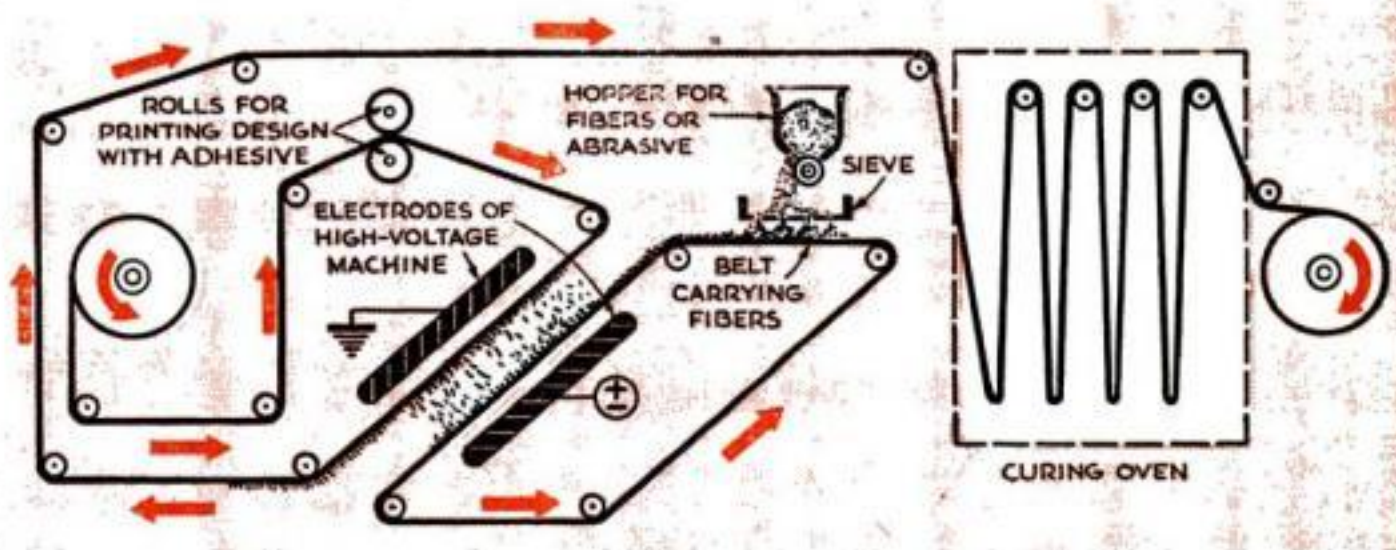
From coating fabrics with abrasive grains to coating them with textile fibers seemed an obvious step, and more years of experimentation produced electro-coated textiles. Direct current, which worked with abrasives, caused bothersome clinging together of fibers, but alternating current made the fibers dart up and down between the electrodes, sticking only when caught by the

adhesive, which itself was a problem. The materials must remain soft and pliant and withstand laundering, dry-cleaning, and ironing. The final choice was a series of thermo-setting resins that could be varied in flexibility to suit a particular need. The adhesive is applied to the material in the required design. When moved into the electric field, fibers, cut to lengths of from .025 to .06 inch, are shot into the material, penetrating to a depth determined by the charge and the adhesive. They stand evenly on end, often packed in at from 250,000 to 300,000 to the square inch.

The first commercially manufactured electro-broidered dress goods, called Fibre-down, are lawns and voiles, figured with raised designs of cotton, rayon, silk, or wool in one or more colors. They are manufactured under a license from the Behr-Manning Corporation.

Norzon, simulated velvet, is being made on a small scale. Liquid latex makes a flexible and durable adhesive here for holding the fibers to the backing. Electro-coated rugs and carpets, with $\frac{1}{4}$ -inch pile, are being tried with indications of a promising future.

WHILE COMPLEX and big, the "making" machine below really is an instrument of delicacy, and sixty miles of sandpaper will go through it on one run. Adjustment is automatic. The schematic diagram at the right shows how the apparatus does its work



Night Watchmen of the Skies

Ingenious Machines Aid Army Searchlight Crews in Air-Raid Protection



Members of a U. S. Army antiaircraft searchlight unit man one of the new three-horn sound locators that unerringly spot night-flying bombers

By JOHN WATSON

DARKNESS and silence cover the scene—the Coast Artillery area guarding a seaboard city—and the activities of the day seem long since to have ended. But in an isolated section, far away from the big-gun emplacements and the barracks, a small group of men are engaged in quiet, intense work. They are the watchdogs of the Army, members of an antiaircraft

searchlight unit, whose job is to detect, track, and illuminate raiding enemy planes and keep them illuminated while crews of antiaircraft gun batteries blast them from the skies.

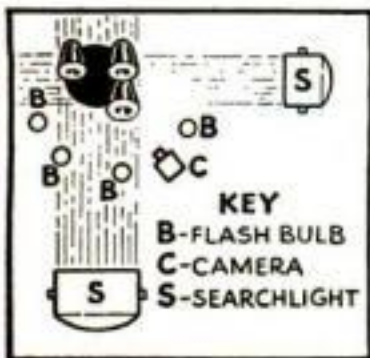
It is an eerie job. A layman observer, permitted to witness a night of practice, sees long lines of cables snaking through the sandgrass, leading from an instrument that looks like a botanist's nightmare—a cluster of weird, mechanical bell-shaped flowers—to other devices that appear squat and formless in the dark.

He sees helmeted men attach themselves to the flower cluster by means of thumb-thick tubes, like an insect's antennae, which are fastened to each helmet's ears and connect with the center of the instrument. He watches the men twist wheels which elevate the flower-shaped horns or turn them horizontally.

He learns that the snakelike cables are transmitting electrical impulses which carry information to one of the squat instruments, 500 feet away, where other men

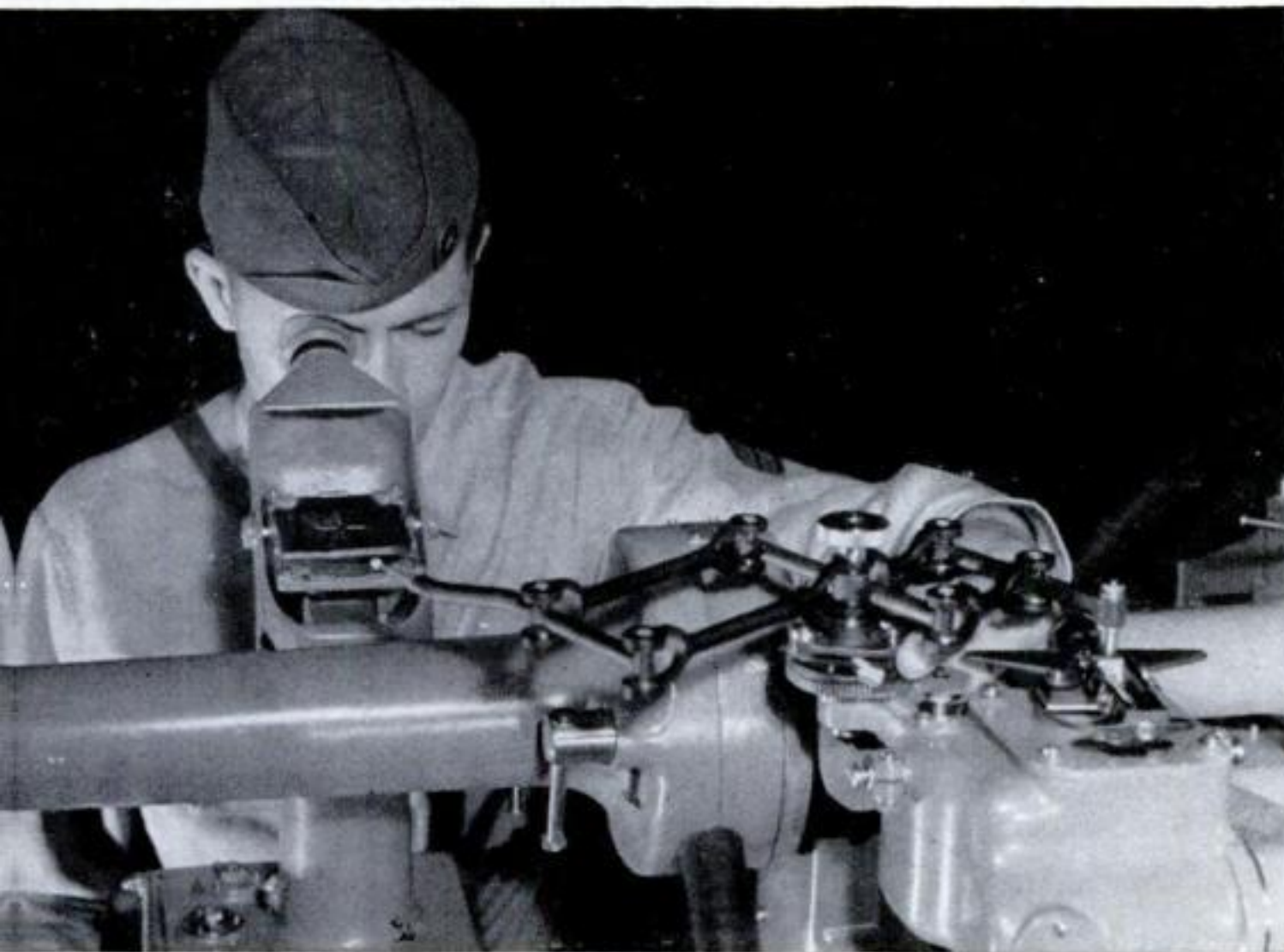
Our Cover

The antiaircraft sound-locator crew on the cover was photographed in the glare of two searchlights, as shown in the drawing. Outdoor Kodachrome film, 1/2-second exposure, f/22. The photograph above was made under similar conditions, except that indoor Kodachrome film was used.



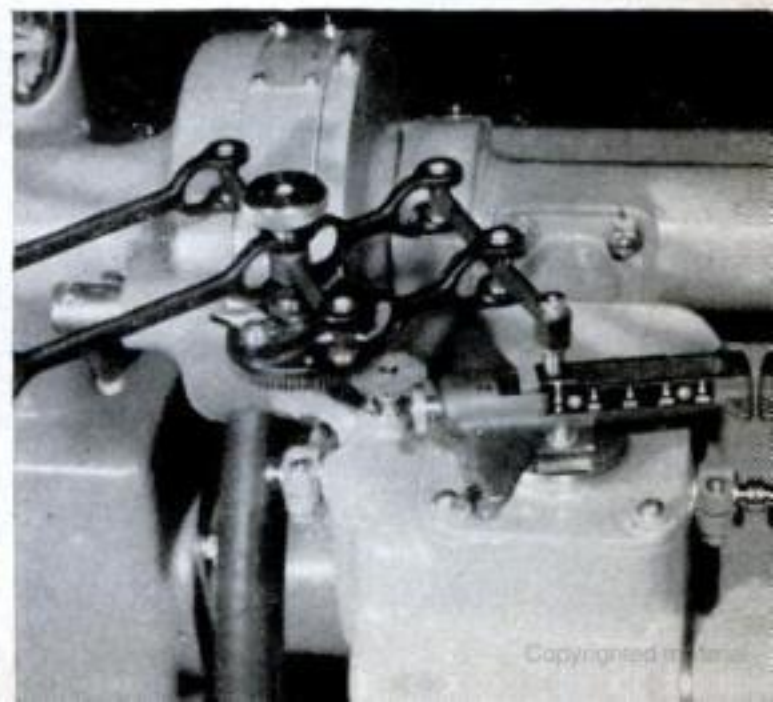
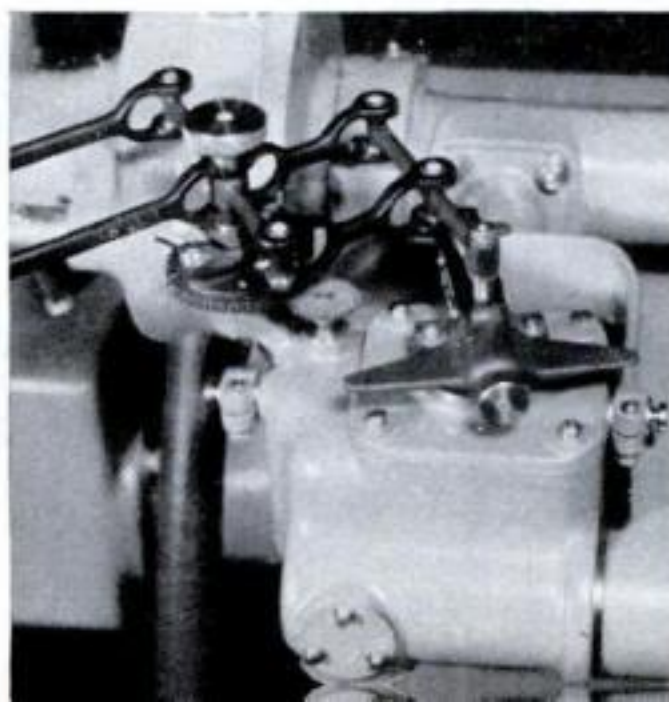
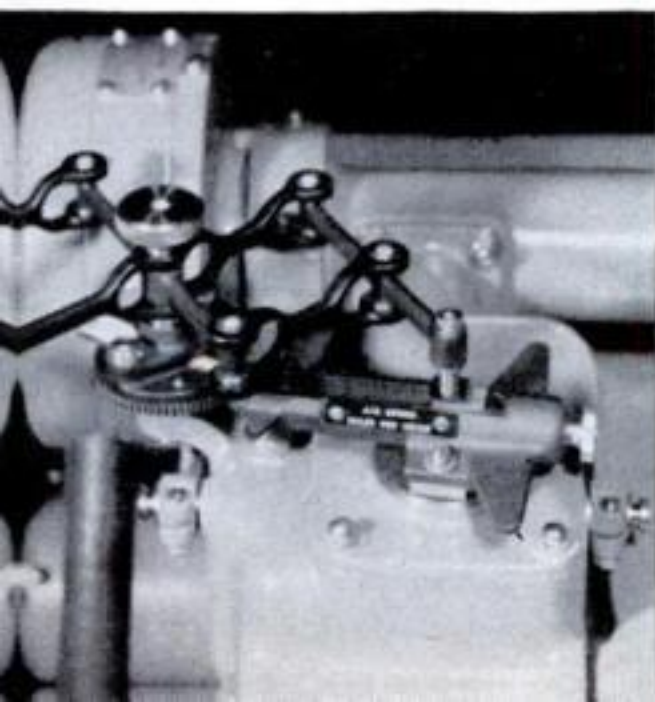
POPULAR SCIENCE

Each listener hears sounds picked up by one of the horns; the other horn is common to both. Together, they fix the point from which sound comes.



THE CORRECTOR compensates for sound lag, the distance the plane travels before the sound reaches the sound locator; wind error, directional changes in the course of the sound caused by the wind; parallax error, created by the ideal tactical disposition of the sound locator and searchlight nearly 1,000 feet apart. Sighting in a mirror, he centers marks on the mirror on a ball at the end of the pantograph that makes correction for all these errors

A miniature plane, part of the speed-corrector assembly to which the pantograph is attached, serves as a visual indication of the course of the target. A speed-corrector scale on its side is graduated in m.p.h.

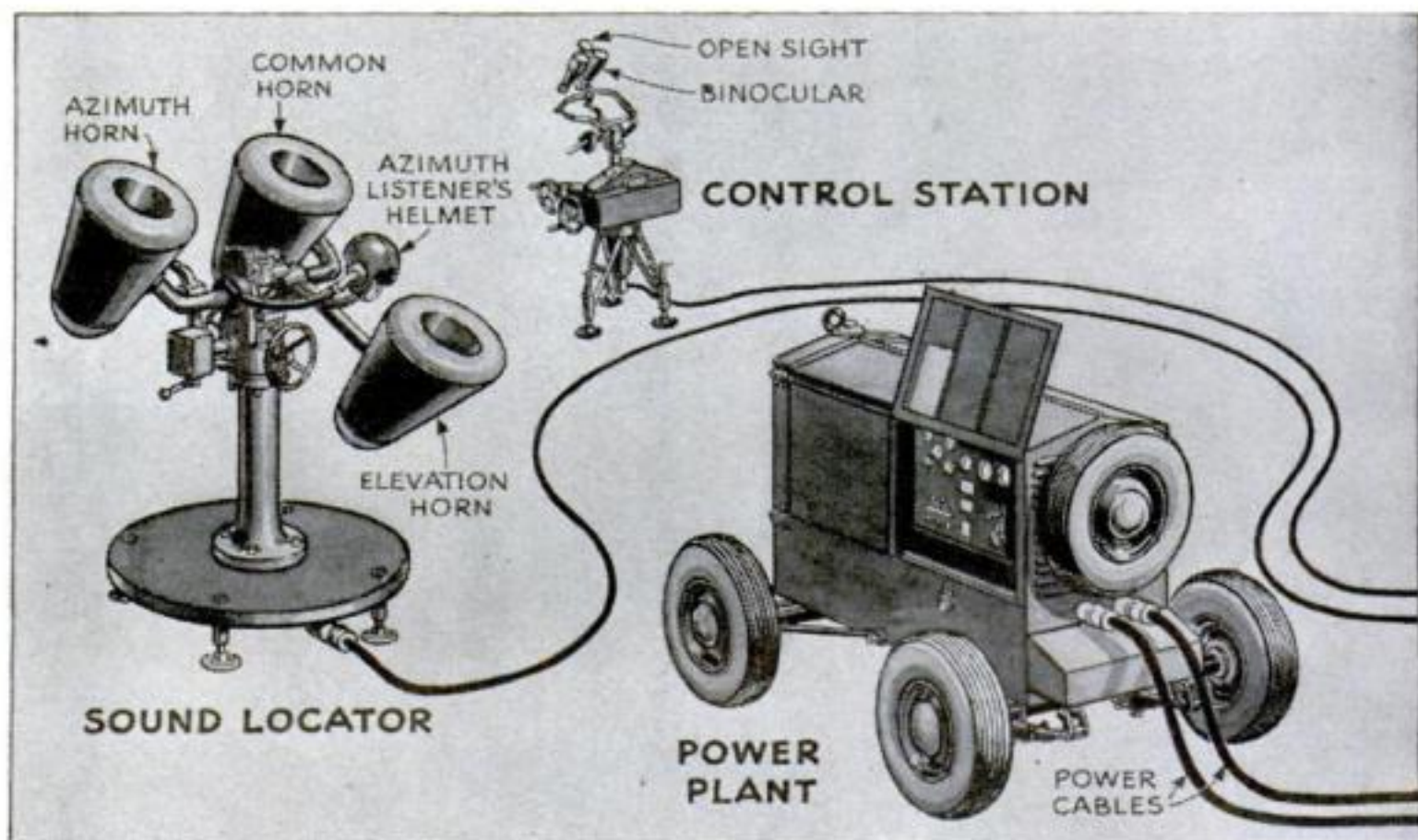




CONTROL STATION aims the searchlight according to data from the sound locator. By turning a hand wheel, an operator keeps a needle on the zero point of a dial to train the light on the spot indicated by the locator. At the same time, the binoculars are trained on the target. When the plane is "flicked," the observer tracks it for elevation and azimuth by manipulating hand controls

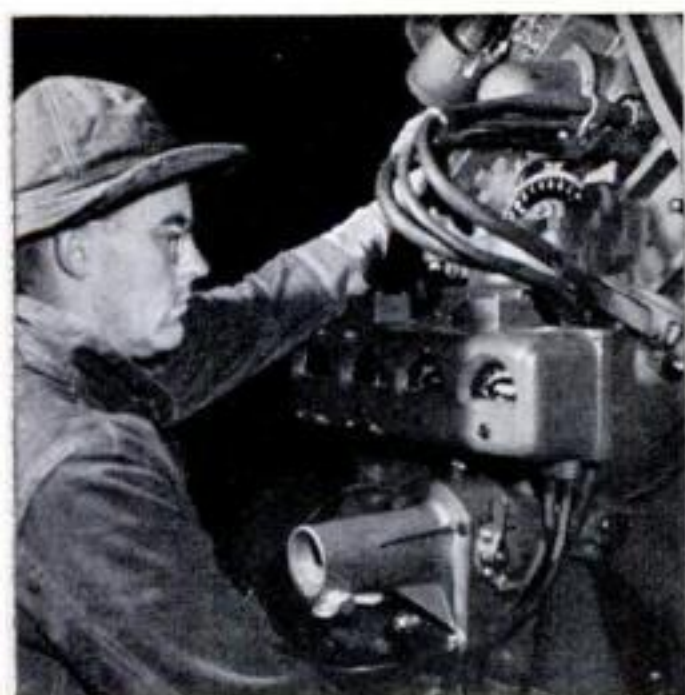


POWER PLANT
Current for the light comes from a mobile unit consisting of an air and water-cooled gasoline engine driving an electric generator that delivers about 150 amperes at 78 volts. Carried or towed to the scene of action by a truck, it is managed by one man

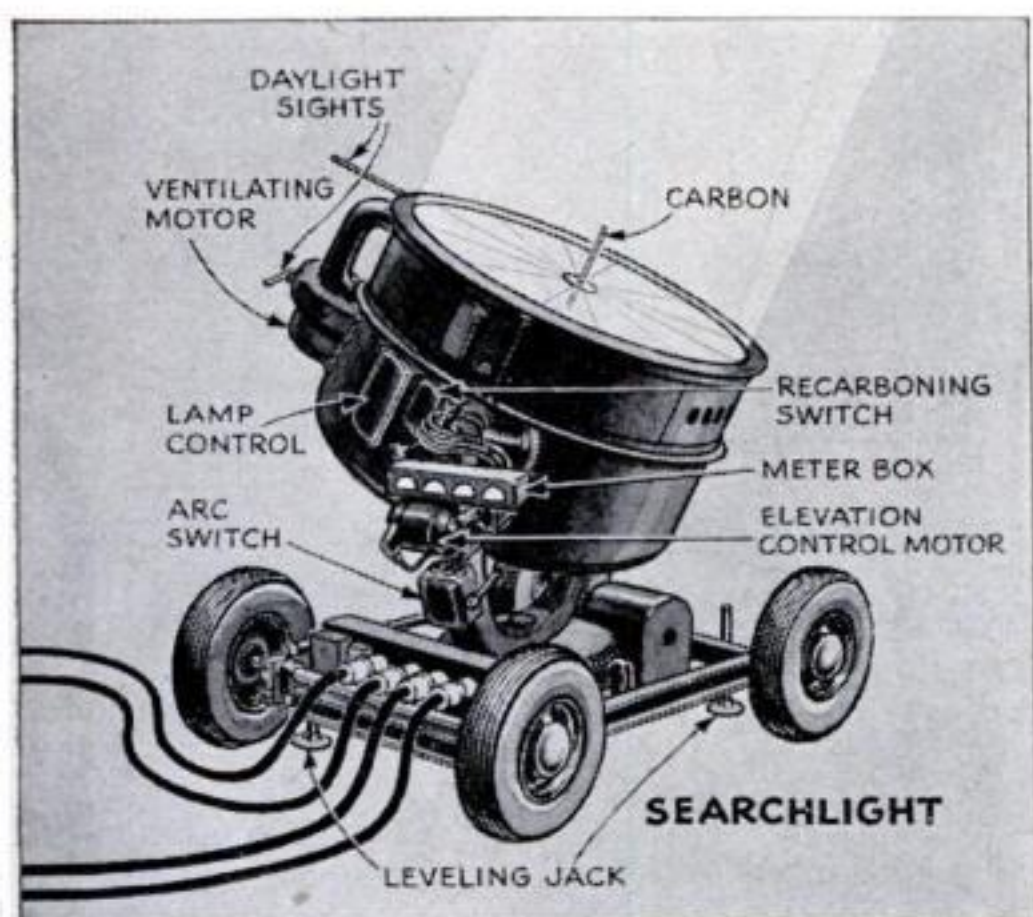


turn wheels and fasten their gaze on dials. He hears the chief of section of the unit give a brief command and suddenly, from a thing that has been dark and dead, perched atop a sand dune, shoots a blinding beam of light—and in the center of that beam, thousands of yards from the ground, the murderous throb of a bomber's motors is transformed in an instant into a clearly distinguished plane. The target has been "flicked" dead center.

To "flick" so fast and elusive a target as a plane demands a high degree of coördina-



THE SEARCHLIGHT is an 800,000,000-candlepower carbon-arc lamp on wheels. In addition to being automatically aimed from the control station, it can be manually operated by one man using a 12-foot control rod and reading azimuth and elevation on illuminated dials. Range: 6,000 to 12,000 yards



tion and an immense amount of practice. The problem of the Army's watchdogs, in its essentials, is to pick up the sound of an enemy plane as far away as possible, determine its position and direction, track it as it approaches, and illuminate it at the earliest possible moment so that the gunners of the anti-aircraft batteries will have something to shoot at.

The first business in hand on this night in the sand dunes is the botanist's nightmare, the sound locator. In its newest development this consists of three bell-shaped

horns attached to a metal column which rests on a platform. The horns are designed to act as huge extensions of the human ear.

The three horns form a triangle and the middle horn is common to the other two. That is, the middle horn is paired with the bottom horn to obtain the elevation of a plane, and with the top outside horn to obtain azimuth, or the horizontal angle, and thus establishes direction. The old-style sound locator had four horns, two for elevation and two for azimuth, until it was discovered that one horn could be made to do the work of two.

Two helmeted men, their headsets attached to tubes leading from the hearing mechanism, face each other on the platform. One, who is the elevation listener, turns a small handwheel and raises or lowers the horns until the thrum-thrum-thrum of the plane's motors seems to be directly in the center of his brain, neither stronger toward the left ear nor stronger toward the right. When he has centered the sound he knows he has the horns set correctly to obtain the elevation of the plane.

Similarly, the second man, who is the azimuth listener, turns his handwheel and moves the horns in a horizontal circle until he, too, has centered the sound in his head and knows that he is on the correct azimuth.

But there is one very important calculation still left out, which requires the presence of a third man, who is known as the

corrector operator. Since sound travels at about 1,100 feet a second it is obvious that when the hum of a plane's motors reaches the locator, the plane has traveled a considerable distance from the spot where the horns would place it.

To correct this sound lag, a small device known as a pantograph is a part of every locator. The pantograph is geared to the locator's tracking mechanism. When the corrector operator has centered the image of a ball, which is on the end of the pantograph, between cross marks on a mirror, he has automatically applied corrections for sound lag, wind error, target speed, and parallax error created by the distance (ideally about 1,000 feet) between the sound locator and the searchlight.

Just below the pantograph is another tiny device, known as a course indicator. This is in the shape of a miniature airplane and is coördinated with the movement of the horns to indicate the direction in which the target is flying.

While the sound locator is an efficient instrument, the great speed of modern aircraft makes its range too limited to be completely satisfactory. The Army, therefore, is developing a new and secret device about which no detailed information can be given. This is a radio direction indicator, based on the principle of similar devices now being used by the British which are said to be able to pick up an enemy plane before it leaves the French coast and track

it across the English Channel. The range of this radio locator is part of the Army's secret, but it extends perhaps up to 100 miles.

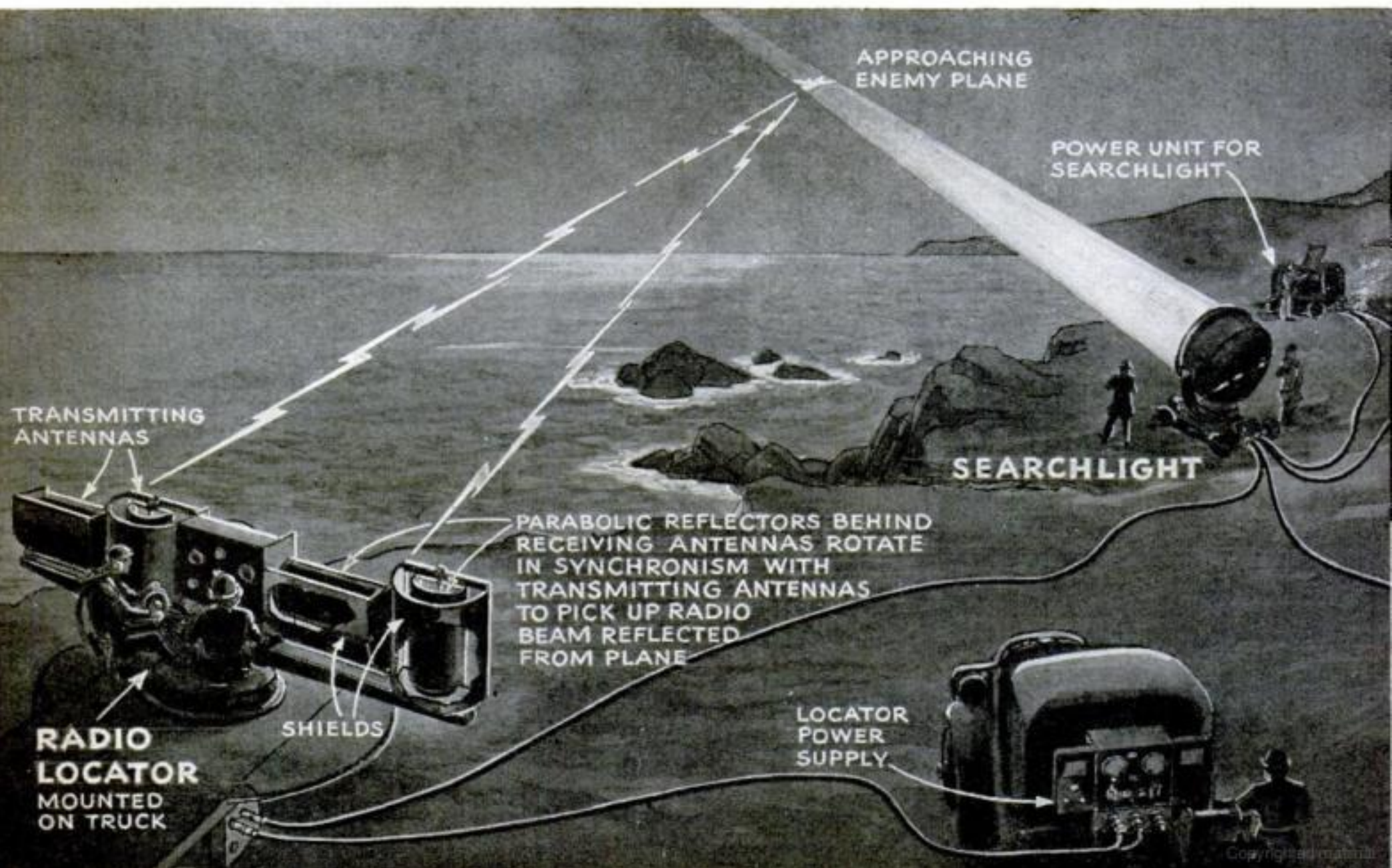
Cables from the binaural sound locator described above lead to the searchlight and thence to an apparatus called the control station, which is operated by three men. The control station, by which the light is moved electrically, is situated at least 50 feet and perhaps as much as 600 feet away from the light. This enables observers to see more clearly, just as a man will hold a lantern away from him in order to avoid being blinded by its rays.

The corrected data flow from the sound locator to the control station where there are an azimuth tracker and an elevation tracker. Here handwheels are turned until the azimuth and elevation dials correspond to the information that is constantly coming in from the locator. The light moves correspondingly as the wheels are turned and at the moment when the plane is believed to be within range the light is turned on.

The anti-aircraft searchlights send out a beam of 800 million candlepower intensity produced by a carbon arc burning in a crater, the light being reflected by means of a parabolic metal mirror. The beam has a range of from 5,000 to 12,000 yards, depending on atmospheric conditions. The light may be operated manually, but usually is controlled from the control station.

One other piece of apparatus is necessary

In a tridimensional radio-locator system recently patented, radio waves reflected from the body of a plane reveal its location. This is not U. S. Army equipment



to complete the set-up of one searchlight unit. This is the mobile power plant, which consists of an air and water-cooled gasoline engine driving an electric generator that delivers about 150 amperes and 78 volts to the searchlight. The power plant is placed, if possible, with a knoll or some other obstruction between it and the other apparatus to eliminate its sound.

Once the lights get on a target the anti aircraft-gun battery goes into action. Contrary to popular impression, there is no close association between a searchlight battery and a gun battery. The two work separately, each with its own instruments. When a target is illuminated, the crew of the gun battery track it by means of a stereoscopic height finder and director, by which azimuth and elevation readings are obtained. Firing data are electrically transmitted to the guns and set by members of the crew by turning hand wheels. The fuse of the shell is cut to explode at the desired height, and the projectile streaks skyward.

So ends a practice night with the Army's watchdogs, as they practice their job of guarding our night skies.

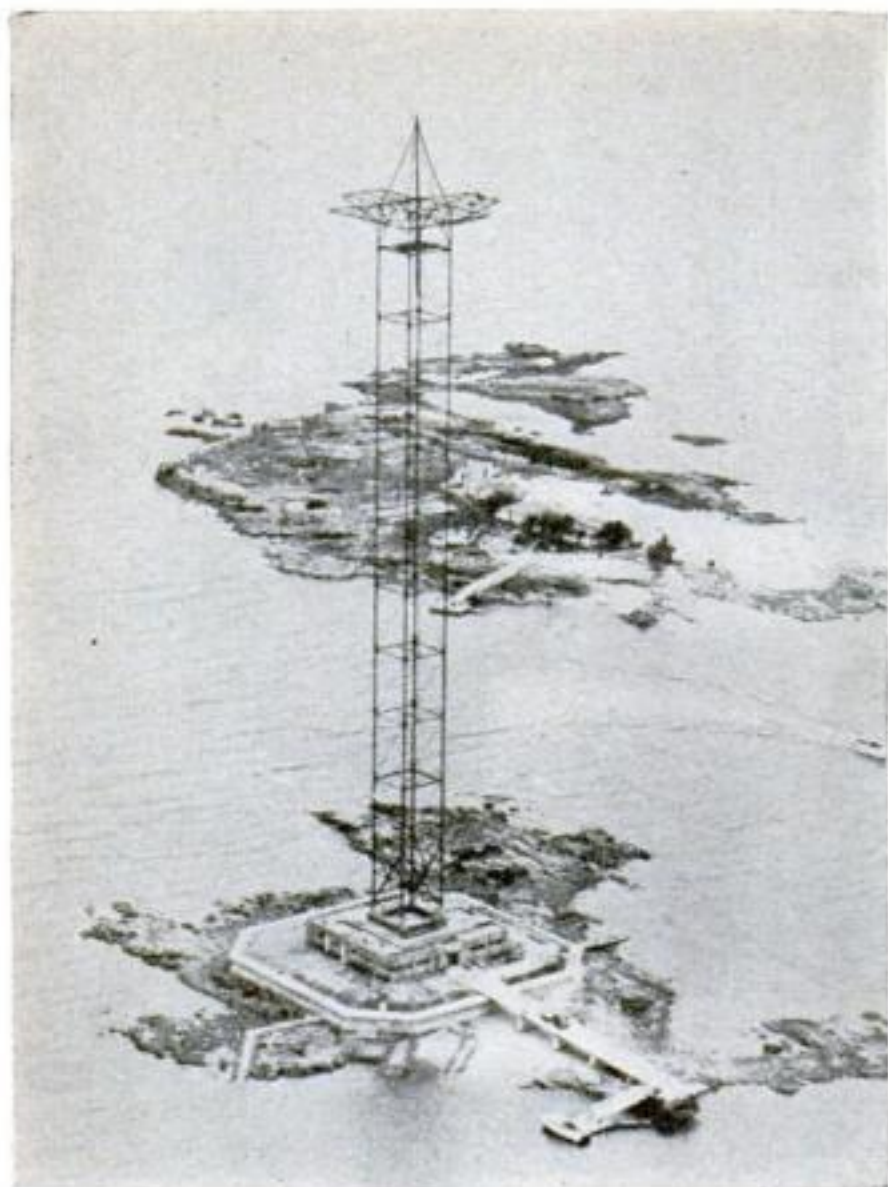


A GUN SWINGS INTO ACTION. Locators and searchlights have only one purpose—to give the batteries something to shoot at. The three-inch plane smasher above can heave its projectile to a height of 9,000 yards at a target illuminated by the big lamp



GETTING THE RANGE. Aiming the guns is an entirely separate operation from training the searchlights. The men below are using a stereoscopic height finder. Their readings go by cable to the director, which adds the direction and speed of the plane



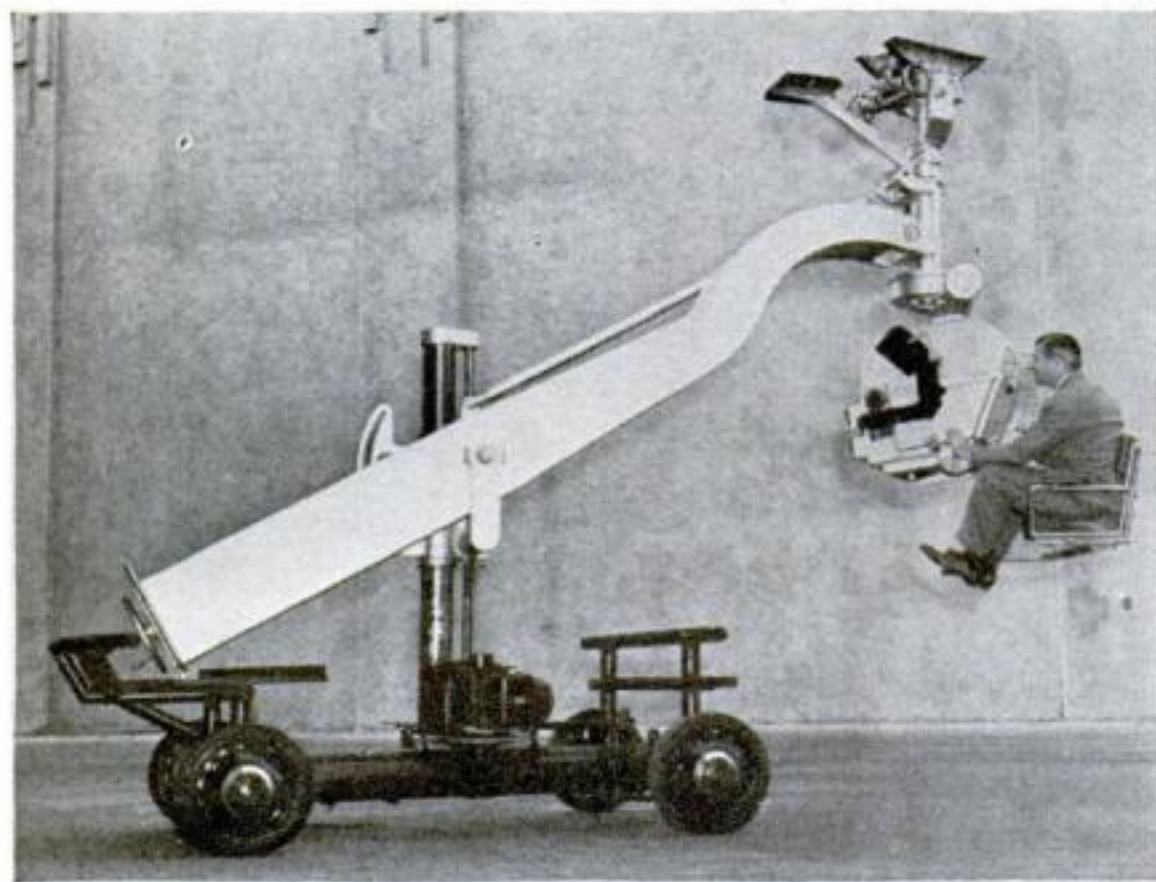


Powerful Radio Station Housed on Tiny 150-Foot Island

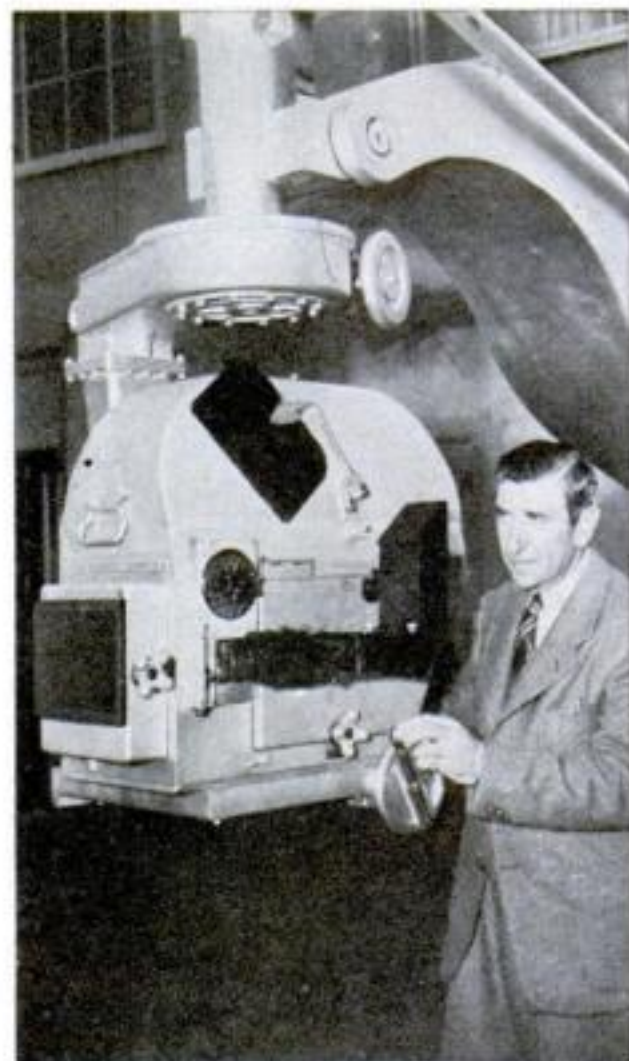
ON AN ISLAND in Long Island Sound, a mile off New Rochelle, N. Y., and only 150 feet square, is the new transmitter of WABC, 50,000-watt station of the Columbia Broadcasting System serving an audience of 14,000,000. It is topped by a 410-foot antenna tower on four concrete pillars, each a yard in diameter, which rest on bedrock and rise through the transmitter building without touching it. Salt water surrounding the station gives excellent transmission.

A fleet of scows, lighters, tugs, launches, and rowboats carried more than 32,000,000 pounds of material to build the station. Three hundred tons of steel for the tower was transported in sections on barges. Four miles of cable, weighing 75 tons, link the station to shore. Current at 4,000 volts can be switched immediately from one cable to another should the first fail. If all power from land should be cut off, a gasoline-driven generator can be put into service in 15 seconds.

Novel Movie-Camera Boom Takes Long Shots and Close-ups



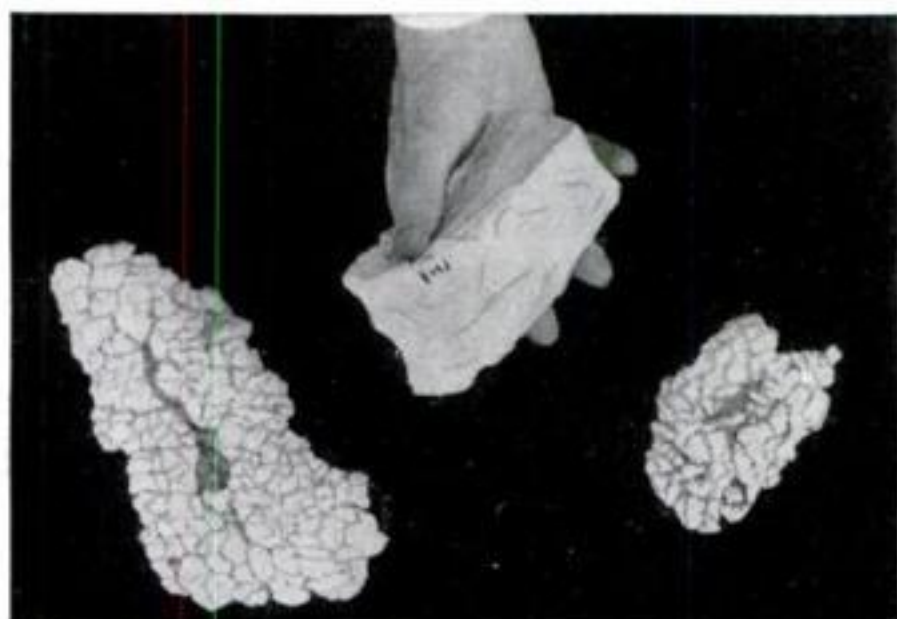
John Arnold, Metro-Goldwyn-Mayer camera chief, at left shows how his novel camera boom works. Below, he operates its quick-action panning device. Note under-slung mounting, periscope finder



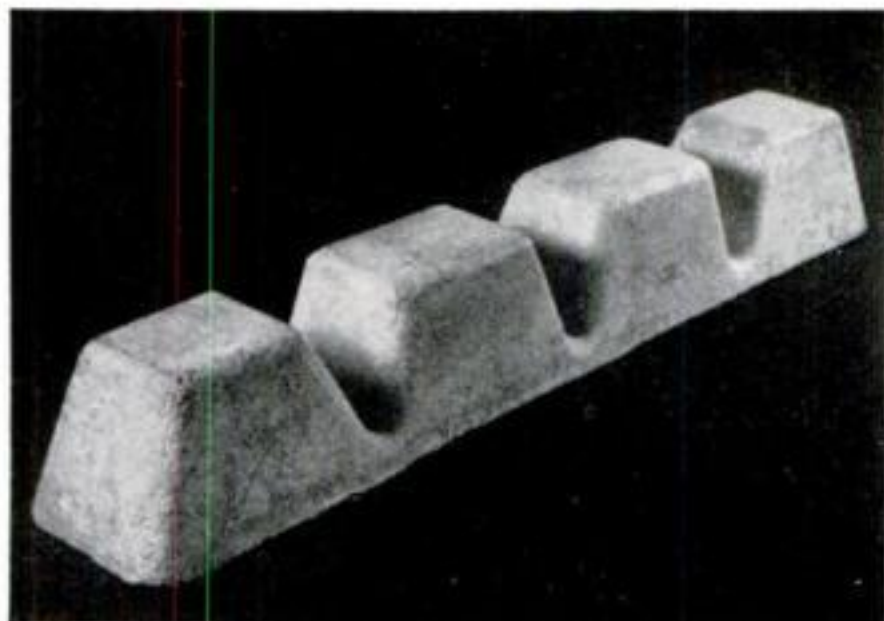
A NINE-FOOT motion-picture camera boom which makes it possible to "truck in" from aerial long shots to extreme close-ups has been designed by John Arnold, camera chief at the Metro-Goldwyn-Mayer studios at Culver City, Calif. A camera on top of the outer end can be raised 16 feet above the stage; one beneath it can be laid on the floor. The boom is raised and lowered by a motor-driven helical hoist, can be rotated through a full vertical circle and turned in its own length. It is valuable in filming such scenes as a long shot of a car moving in to a close-up of its speedometer.



Workers at the Wright foundry, Fairlawn, N. J., pouring molten magnesium to cast an engine part



SOURCE AND PRODUCT. Above are specimens of magnesite, a magnesium-bearing mineral, from (left to right) Cuba, California, and New Jersey. Below, an ingot of magnesium ready for the foundry. About two feet long, this chunk weighs only 21 pounds!



LIGHTWEIGHT CHAMPION OF THE METALS

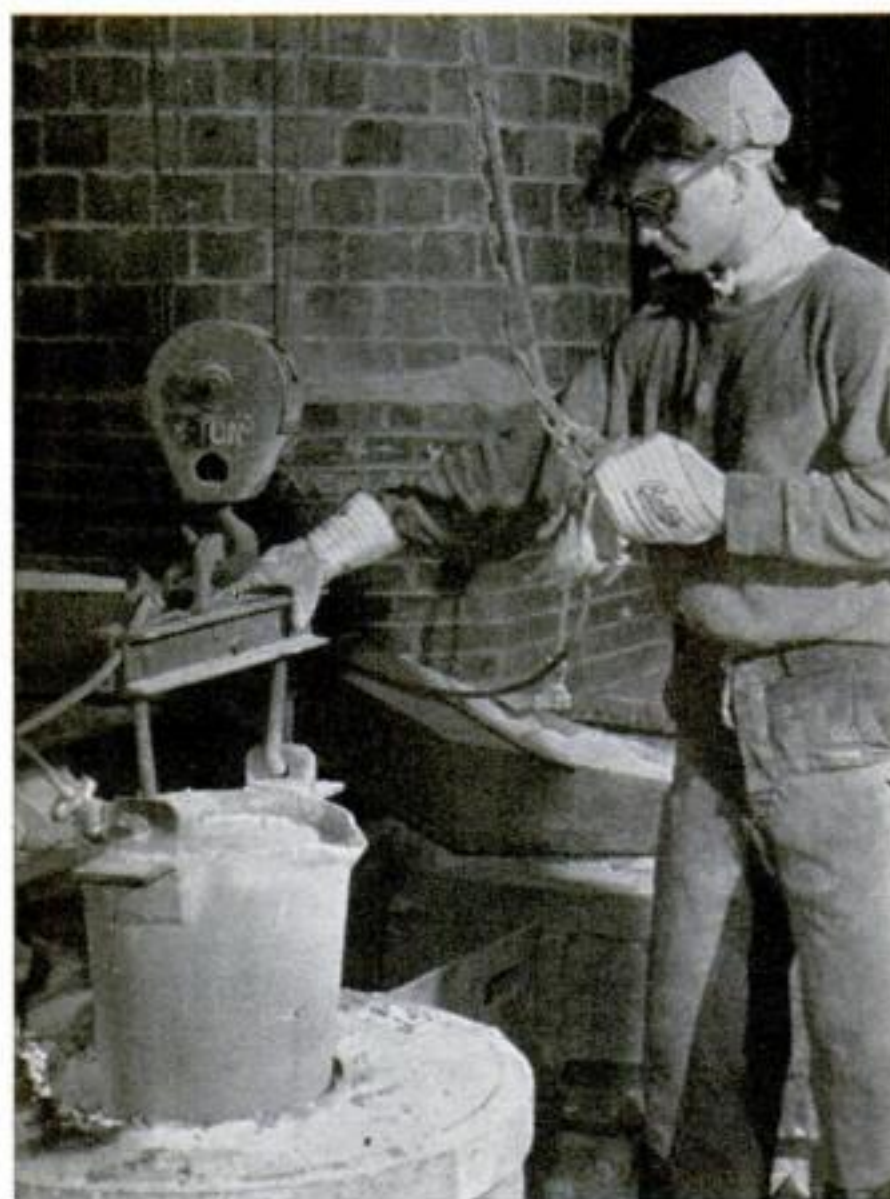
**Magnesium Saves Pounds
in Plane Engines, Making
Lift for Men, Guns, Fuel**

By **ALDEN P. ARMAGNAC**

THE YEAR before Hitler marched his troops into the Rhineland, the United States produced only 2,000 tons of a metal called magnesium. War came, and our 1939 output reached 3,000 tons. The fall of France spurred U. S. preparedness and boosted the 1940 figure to 6,000 tons. For magnesium, lightest of structural metals, was finding new places in warplanes to defend America. And now our giant aircraft program makes these figures seem picayune. Our output of urgently needed magnesium metal is expected to reach a yearly total of 15,000 tons for 1941, 45,000



FLUX TAMES FIERY METAL. Throughout the foundry process, molten magnesium must be kept covered with an oxygen-excluding film to prevent it from spontaneously bursting into flame. This is done by continually sprinkling on it a flux of sulphur and boric acid. Above, a worker adds the flux to magnesium as it goes into a crucible



A one-ton monorail hoist smoothly lifts the boiler-steel crucible of molten magnesium so a ring bar can be slipped under it for carrying to the mold

tons in 1942, and perhaps more than 60,000 tons ultimately.

For extracting it from the mineral known as magnesite, at three big plants to be erected in Nevada, the Government has just awarded a \$63,000,000 contract to Basic Magnesium, Inc. Production of the silvery, featherweight metal from the same source recently began in the first unit of the Permanente Corporation's \$9,250,000 establishment near San Jose, Calif. And the Dow Chemical Company, which has been obtaining magnesium from brine wells at Midland, Mich., has just opened a great \$5,000,000 plant at Freeport, Texas, for recovering magnesium from sea water!

Figures again speak louder than words to explain the sensational magnesium boom. Aviation gets the lion's share, 75 percent, of the principal kind of magnesium marketed—a structural alloy containing a scant amount of other metal, such as aluminum. A typical pre-alloyed ingot like the one pictured on the preceding page measures about two feet long. Lift it and you will get the surprise of your life, for it weighs only 21 pounds. It would take two men to carry a cast-iron ingot of equal size. Notches in the solid metal enable a foundry worker to break off a desired quantity with a sledge, and add it to a melting crucible.

Makers of airplane engines and propellers consume 64 percent of aviation's high-purity magnesium; airplane-wheel manufacturers, 19 percent; and airframe makers, 17 percent, according to a Government report just off the press.

Wright Aeronautical Company engineers estimate that 91 pounds of weight is being saved in each 14-cylinder, 1,700-horsepower motor by substituting magnesium for aluminum in nose covers, supercharger housings, and smaller fittings. On a four-engine bomber, this amounts to an increase in "payload" of a barrelful of gasoline, or nearly the equivalent of two extra crew members.

Magnesium-alloy wheels for large land planes have proved so satisfactory that more than three fourths of the aircraft under construction are being equipped with them. Parts of aircraft frames employ the metal, and experiments are under way with a plastic fuselage molded over magnesium reinforcements. Full-size wing panels of magnesium are being tested. Aluminum-base alloys continue to make up by far the major structural weight of a plane, but even these contain a small proportion of magnesium, which is a third lighter than aluminum.

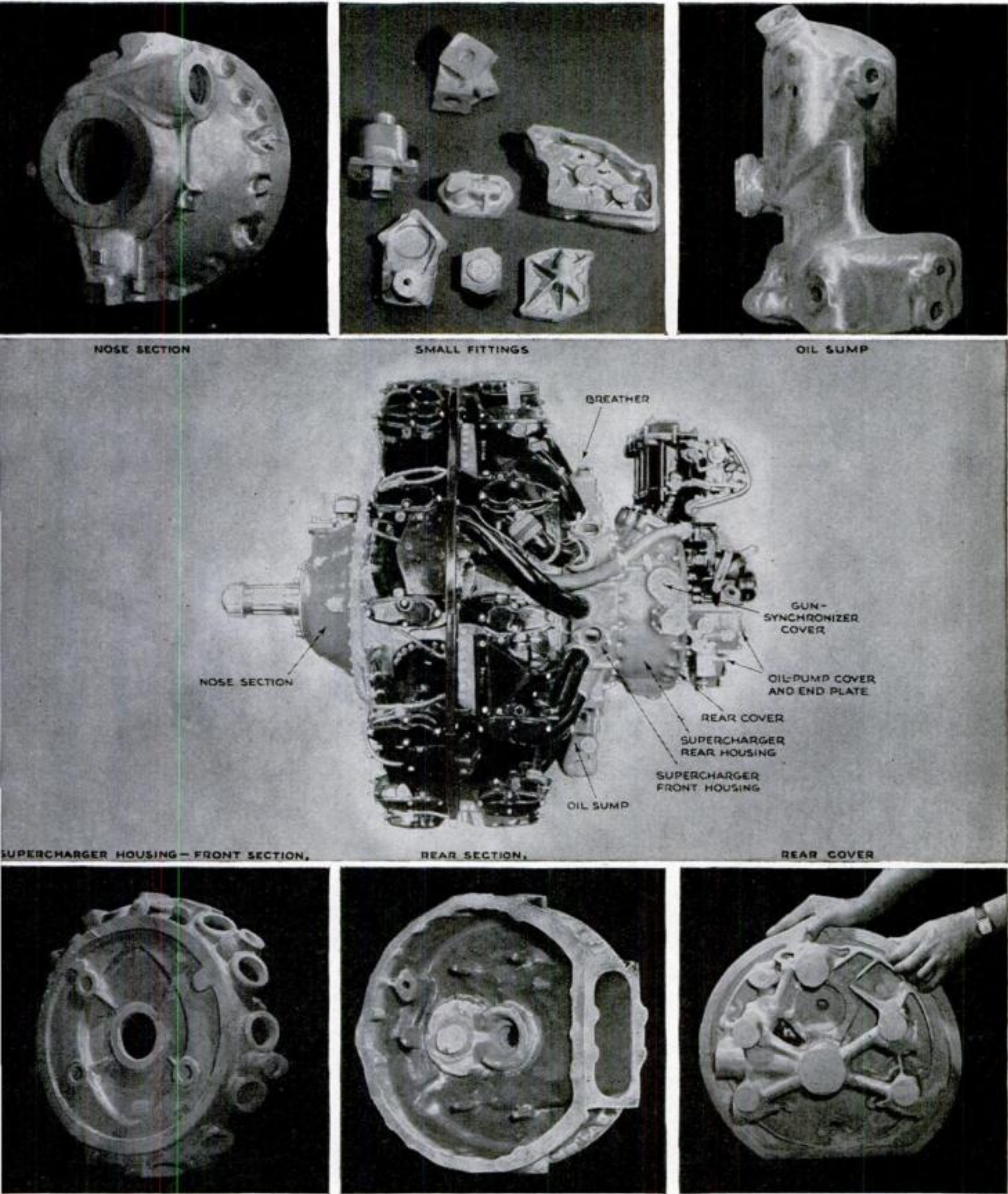
Nearest competitor to aviation, the automotive industry uses only ten percent of high-magnesium structural alloy, in parts of automobile and tractor bodies, starters, and

generators. Next come makers of portable appliances such as typewriters, sewing machines, vacuum cleaners, drills, and polishing tools, which account in all for about six percent; the rest is scattered among a diversity of industries.

Besides extreme light weight, there lurks within magnesium another terrible but useful property—the dazzling inferno of flame

with which it burns when in powdered or molten form. A reasonably thick piece of solid magnesium will not ignite, as a lecturer once demonstrated before the Electrochemical Society by smoking a pipe fashioned from the metal. But veteran photographers well remember the blinding light of burning magnesium in flashlight powder and ribbon form. Today it serves in many kinds of mu-

How and Where Magnesium Cuts Weight of Airplane Engines

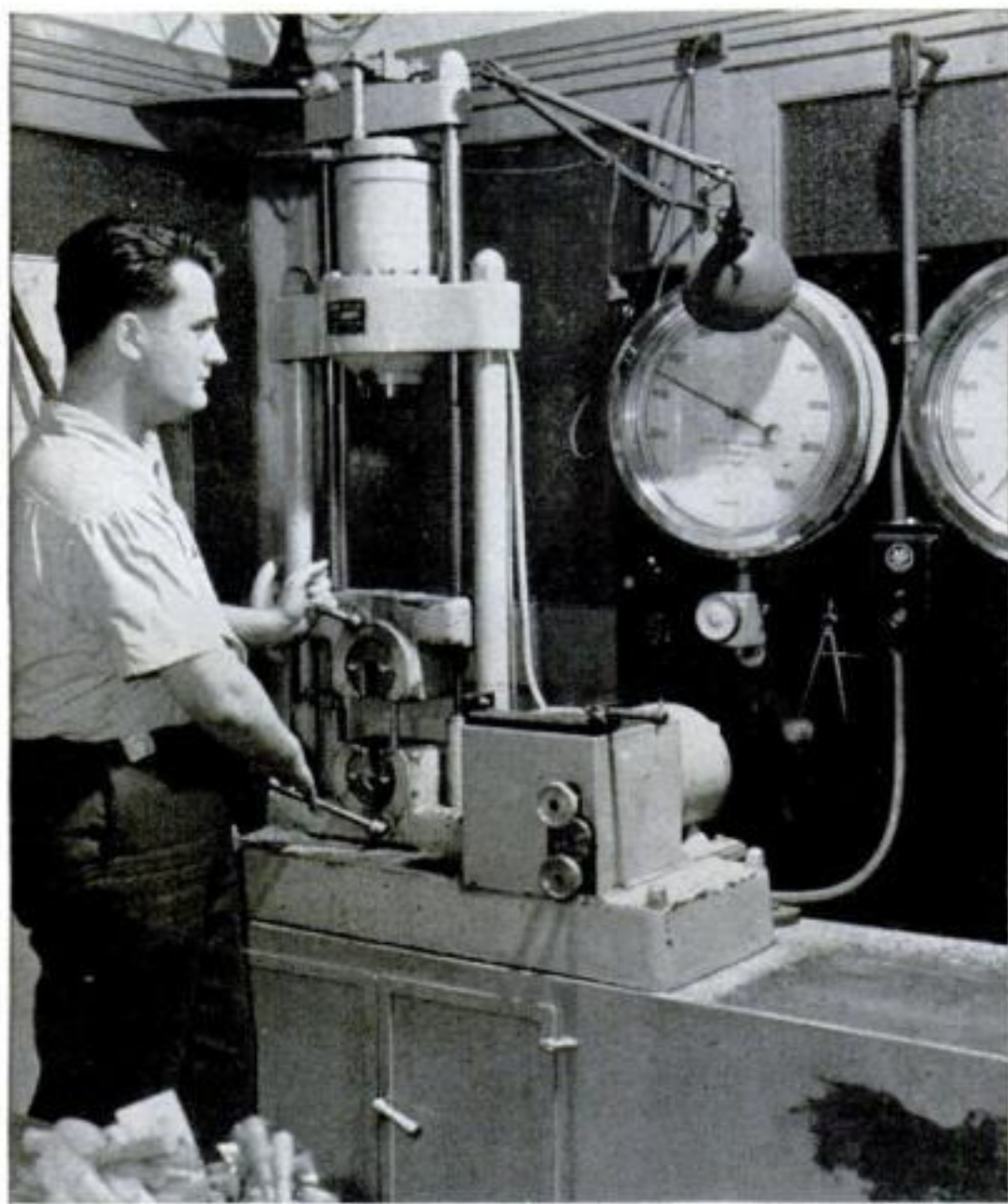


nitions such as tracer bullets, flares, and star shells.

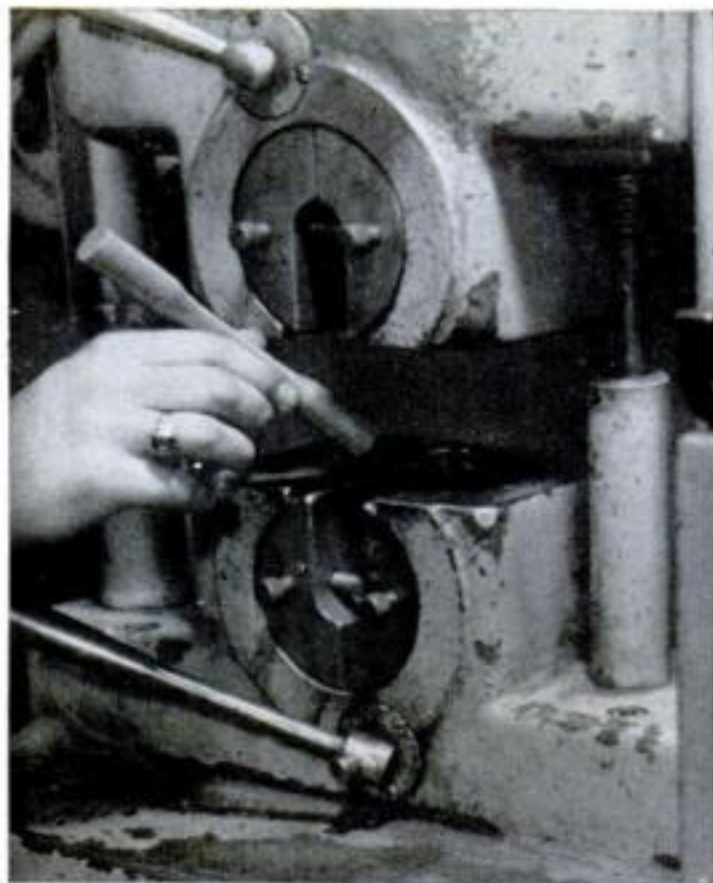
Heated above 1,200 degrees F., solid magnesium melts and spontaneously ignites on contact with air. The result is one of the most dangerous of incendiary bombs in use abroad. Missiles of this type weigh only about two pounds apiece, so that a single plane can carry 1,000 to 2,000 of them, and drop them on rooftops with little noise. An impact fuse ignites a filling of thermite, a fiercely burning compound sometimes used in welding. In turn, its heat melts and ignites the casing of the bomb, which is made of magnesium! Here is a weapon of almost 100-percent efficiency, starting two kinds of fires that water will not extinguish. The thermite burns at 3,000 degrees centigrade for about one minute, and the magnesium casing burns about 15 minutes. The best way to put out such a bomb is with sand.

But American industry has had to lick

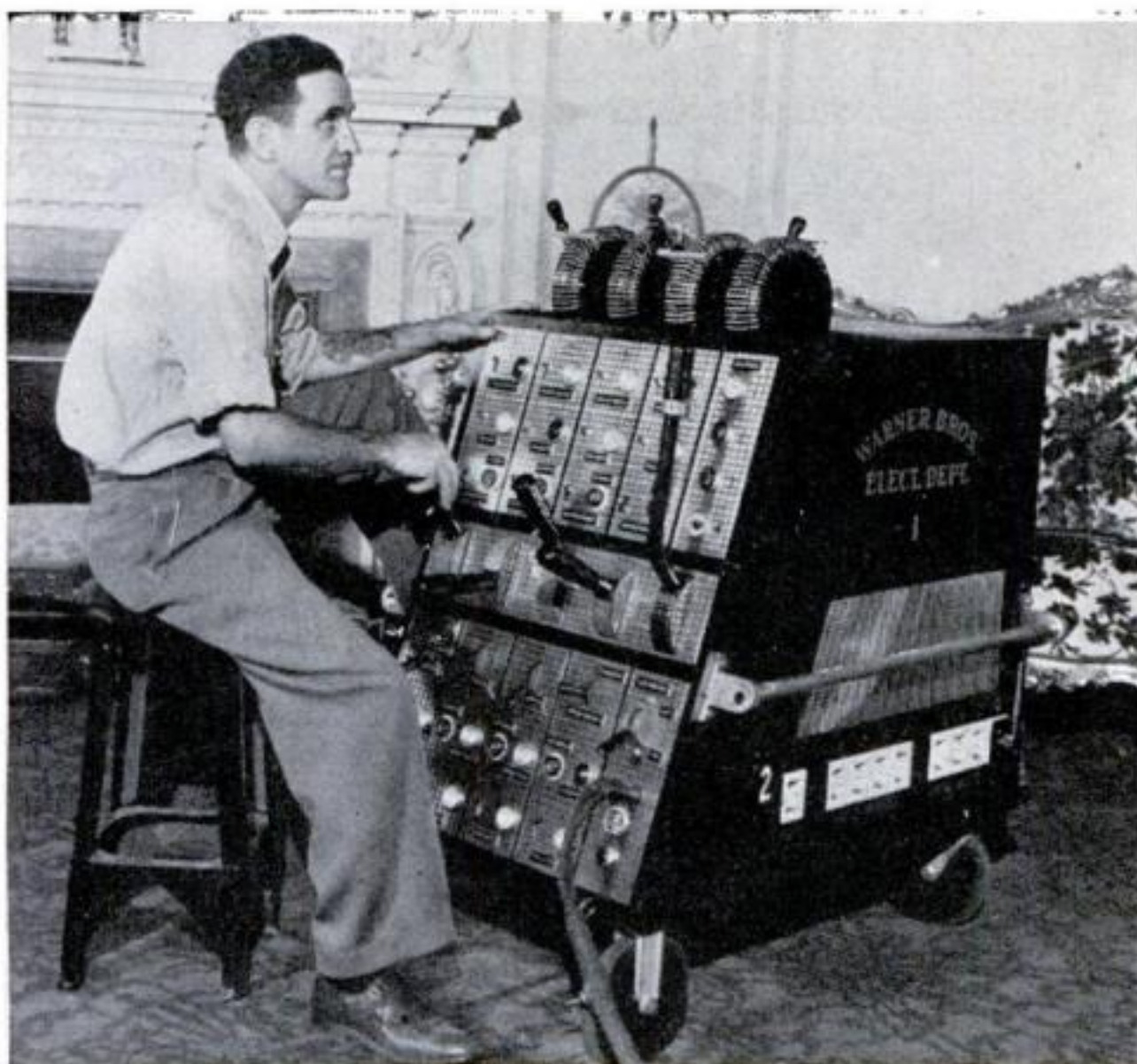
the same problem, in order to melt the Jekyll-Hyde metal and pour it safely into molds. The moment you enter the world's largest magnesium foundry at Fairlawn, N. J., which turns out ten tons of castings for Wright engines in a 24-hour day, an all-pervading odor of sulphur tells part of the secret. Here is a worker tending 100 pounds of molten, slag-covered magnesium in an oil-heated crucible, intent on dousing each bright spark that flashes up with a scoopful of "flux" containing sulphur, boric acid, and other chemicals. Another man, with a shaker such as bakers use to sprinkle doughnuts with powdered sugar, applies a sulphur-and-boric-acid flux when the crew of ladlemen direct the glowing stream of liquid metal into the sand mold for a casting. By forming a thin but effective oxygen-excluding film, the fluxes tame the fiery metal to which America and her warring friends look for air supremacy.



Before magnesium castings leave the foundry, correspondingly marked test samples go to the laboratory. In the machine above, they are stretched, compressed, and given other physical tests, while dials show the results. The photo at upper right shows a sample being placed in the jaws of the machine. At the right, a supercharger is being given the "bubble test." With outlets plugged, it is filled with compressed air and held under water. Escaping air betrays porous metal or cracks



Switchboard Near Camera Controls Movie Lights



MOVIE electricians no longer need carry lights in and out to "balance the set," since the invention by I. M. Combs, chief electrical engineer at the Warner Brothers studio, Burbank, Calif., of a control switchboard which dims any one light, any group, or all at once. Placed near the camera, it permits the operator to watch the action. A master control dims through 110 steps to avoid flicker. Each control circuit is numbered, and when a lamp is plugged in, a tag with a corresponding number is hung on the lamp, so the operator can instantly follow an order by the cinematographer for the dimming of a given lamp or lamps in filming a scene.

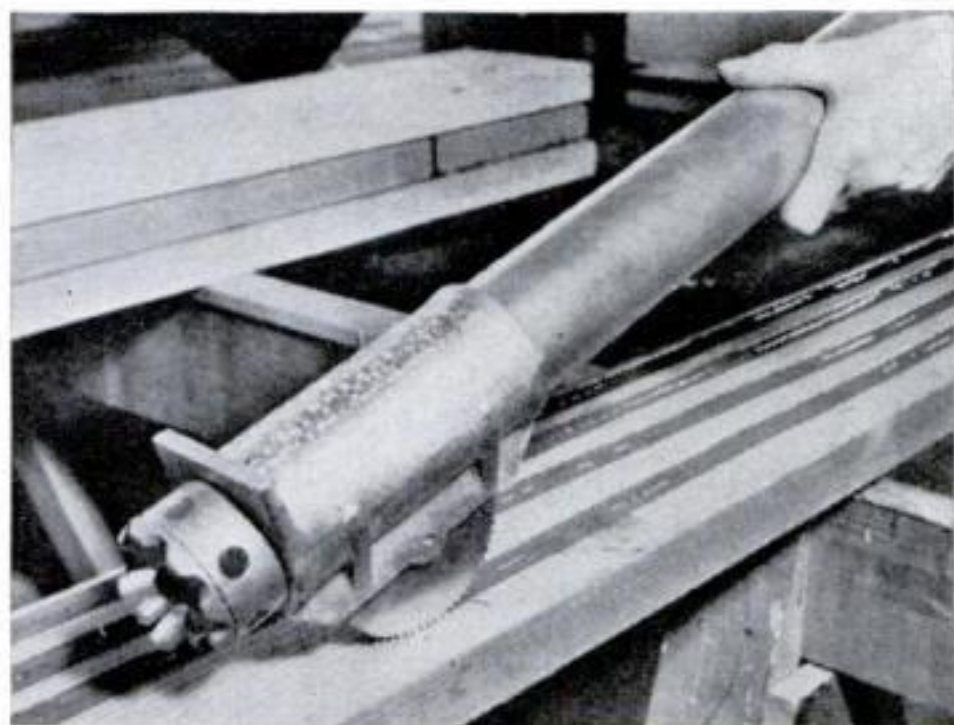
At the controls, the switchboard operator watches the action on the set

Gun Shoots Even Coating of Glue Regardless of Its Angle

GLUING wall boards to studs in housing construction is simplified by a gun which can spread two quarts of glue in an even one-inch line on 408 feet of studding. A doctor bar combined with a corrugated roll at the nose assures a uniform flow no matter how the gun is tipped or whether it is full or nearly empty. A saving of two thirds of the labor of brush gluing is claimed, plus the elimination of the usual wasting of glue.



Used in putting up prefabricated wall boards, this gun spreads its trail of liquid glue as evenly on studs as it does on a flat surface





Delegates to the Fifth Annual Work Simplification Conference at Lake Placid, N.Y., working out their individual solutions to factory problems in the laboratory at the Lake Placid Club. Each represents a company which has invested \$1,500 and six weeks of an employee's time to add efficiency to its operations

Putting More Minutes

SPENDING time to save time is proving a profitable investment for American companies sending representatives to the annual Work Simplification Conference, at Lake Placid, N. Y. Each concern invests \$1,500 and six weeks of an employee's time. In return it gets the solution of a pressing manufacturing problem and ideas for stepping up production and cutting manufacturing costs through the elimination of waste minutes, motions, energy, and materials.

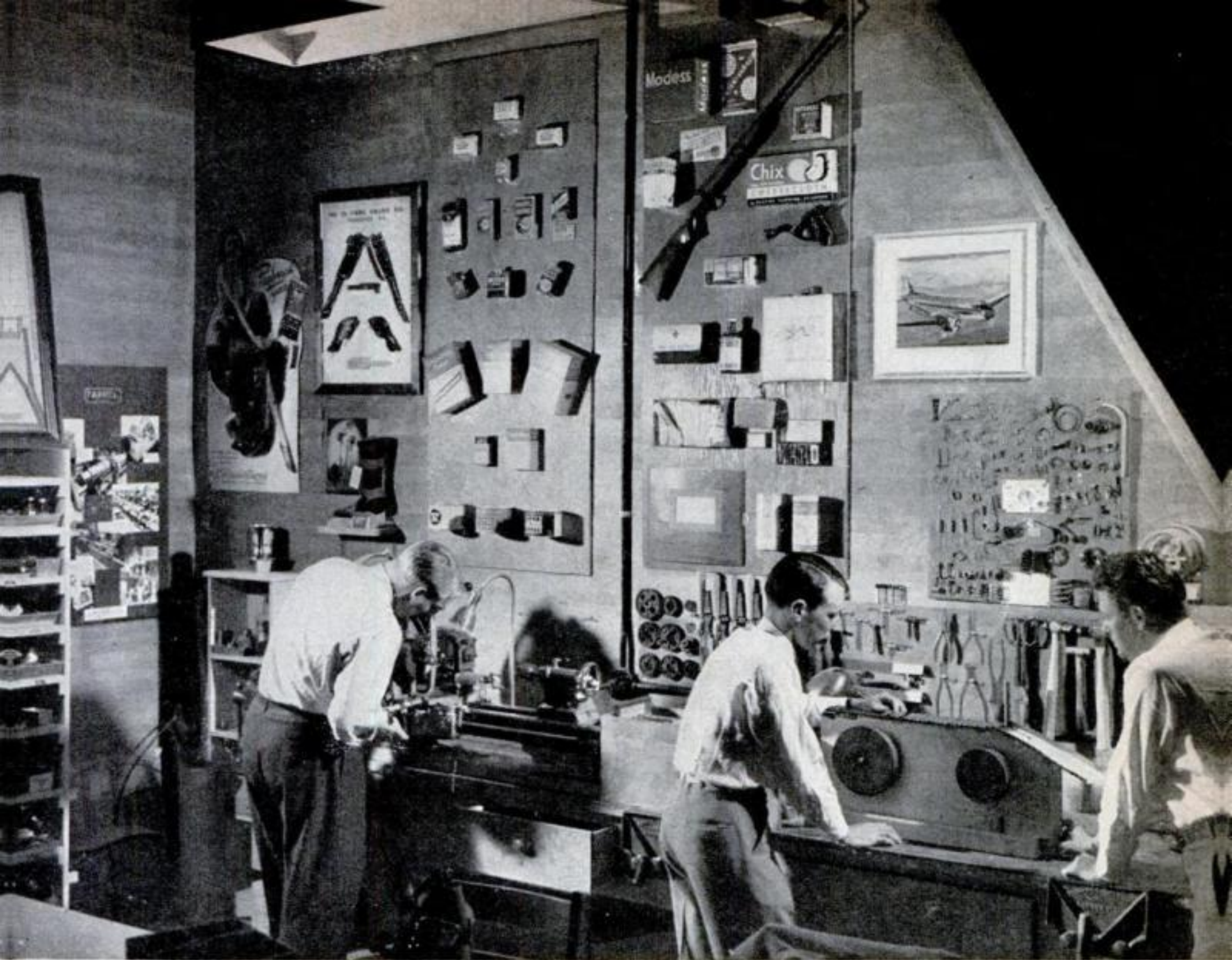
The conference, which completed its fifth year this summer, is headed by the noted industrial consultant, Allan H. Mogensen, of New York City. Among organizations benefiting from ideas obtained at

Dale Marks, from the Walter Baker Co., demonstrates the old method used in packing cartons with assorted chocolate bars



BEFORE

**14 CASES
PER HR.**



Three conferees at work on projects. The laboratory is equipped with a complete set of power tools for use in working out labor-saving devices. On the walls are products of various firms which have sent representatives to Lake Placid to study work simplification and apply it in their plants to save time and money

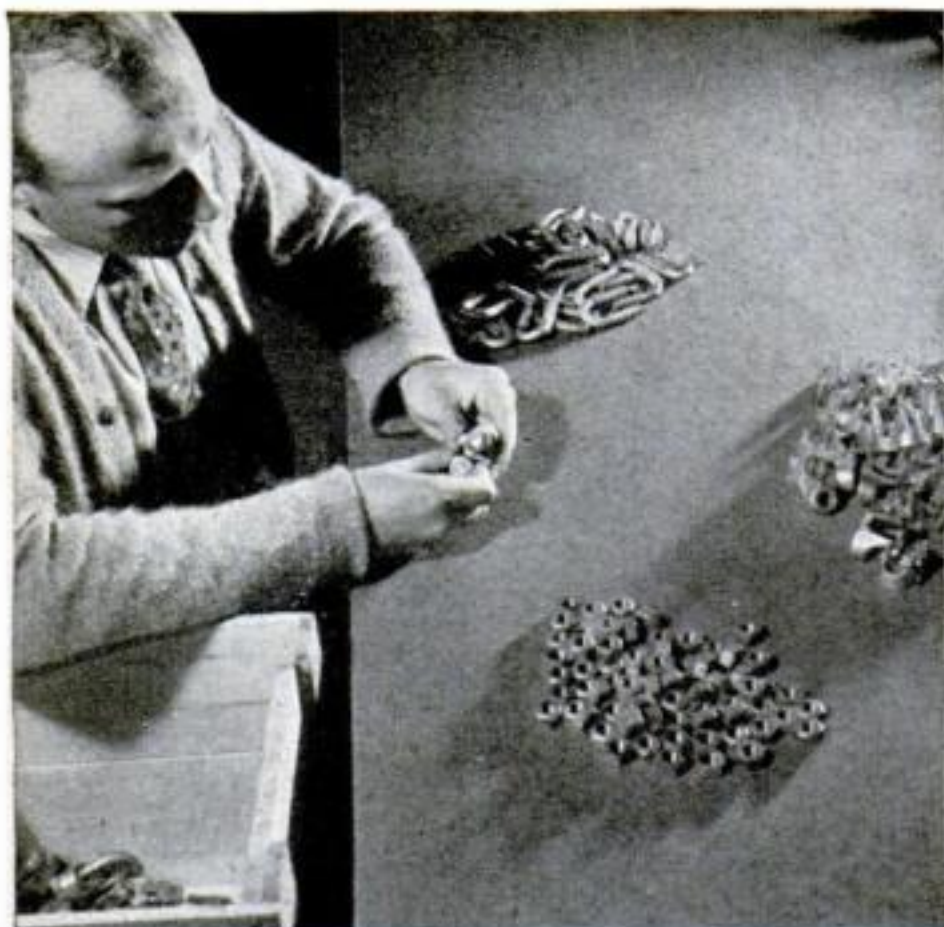
Into Working Hours



Lake Placid are such outstanding companies as Remington Arms, Republic Steel, Lockheed Aircraft, Bakelite, International Business Machines, Johns-Manville, E. I. du Pont de Nemours & Company, and United Air Lines. In an eastern factory producing gas masks, work simplification has already boosted production in one department 200 percent. At a surgical-appliance plant, minute-saving ideas have cut the cost of a first-aid item 32 percent and have boosted the sales 410 percent.

For the foremen and junior executives who attend the conference at the beautiful Lake Placid Club, the six weeks are anything but a vacation. Everybody is up at 7:30

This is the double-tier chute he worked out to speed the work. Feeding bars to a packer, it enables her to use both hands



At Republic Steel, cable clamps used to be assembled by hand in the haphazard manner illustrated above, and then thrown into a box at the side. A 50-percent increase in production is possible with a new method



... in which saddles are pushed over the nuts in a simple, fast operation. Hooks then go over saddles and assemblies are dropped in a hole. Note the handy bins provided to hold the parts

in the morning and work begins an hour later. After lectures and moving pictures that stress the fundamentals of work simplification, individual delegates tackle their specific problems. All the sessions are informal and the men often pitch in and help each other with their manufacturing headaches.

After lunch, the main scene of activity is the conference laboratory. Here, with the

aid of a complete set of hand and power tools, the delegates work out original gadgets that will speed up production in the manufacturing, assembly, or packaging departments of their respective factories. Apparatus invented in this room has meant a saving in hours and dollars in scores of American plants.

At last summer's conference, almost every one of the 25 delegates came with a



Allan H. Mogensen, head of the Conference, filming a project posed by Prof. David B. Porter of New York University. All completed projects must be filmed, with the old methods they replace, for reference use



Delegates learn how to handle movie projectors, in order to be able to show films at their home plants. Thus they can show workers how to follow the new methods, and the reasons for them

different problem. Many were seeking short cuts to greater production in vital defense industries. A glance at a few of the puzzles tackled and solved at Lake Placid will illustrate the practical nature of the meetings.

Vultee Aircraft, for example, wanted a simpler, quicker method of fabricating wire assemblies used on its military planes. Under the old method of manufacture, a worker cut the wires to the correct length, stripped the ends, put on the identifying

tapes, attached the lugs, and inserted the ends of the wires in the automatic terminal squeezer—the whole operation consuming five minutes. During his visit to Lake Placid, Joseph Druliner, the Vultee representative, worked out a simplified method of manufacture, employing a cutting meter and automatic stripper. It reduced the time of fabrication from five minutes to 48 seconds! That saving, multiplied an infinite number of times, will help get a greater number of fighting planes into the air in a



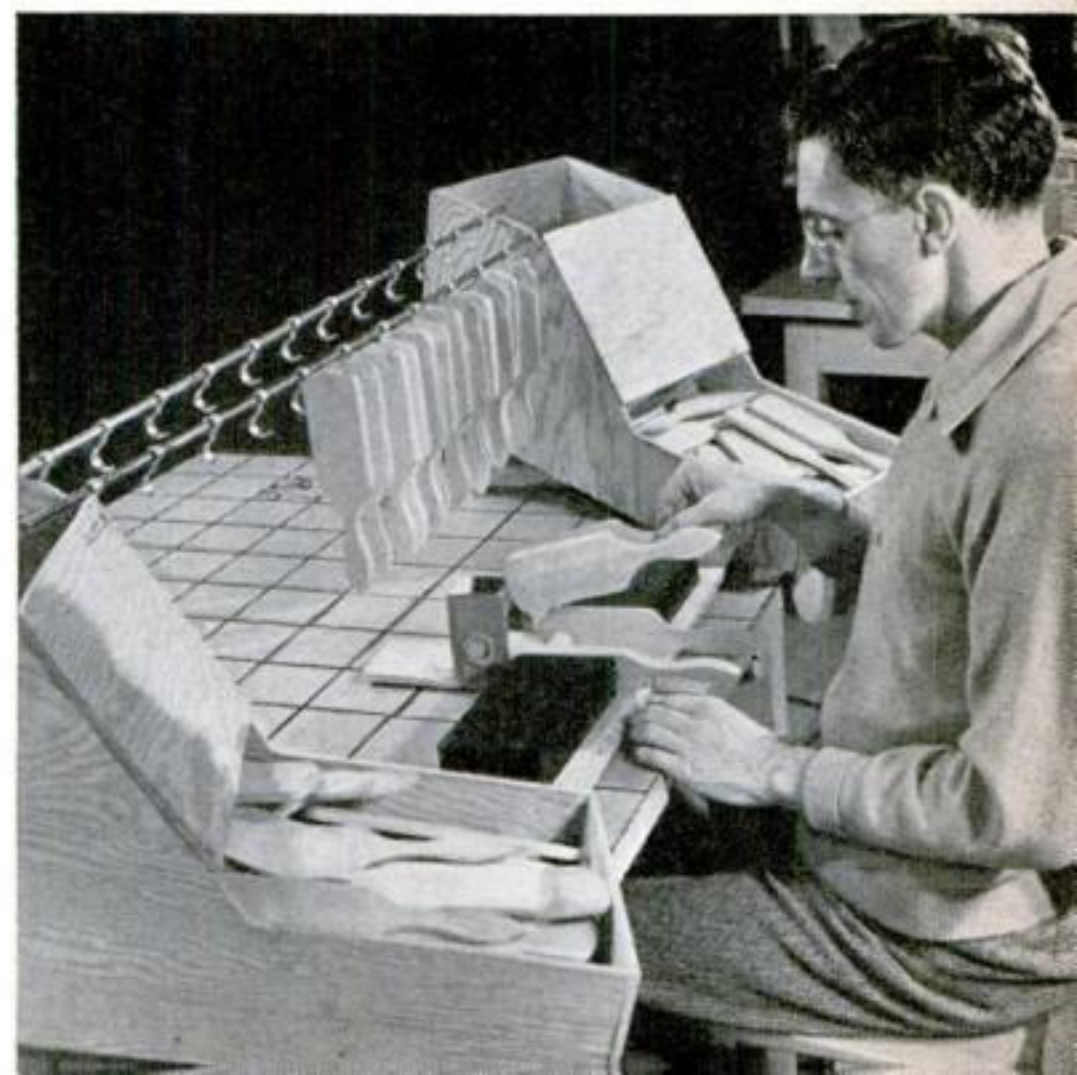
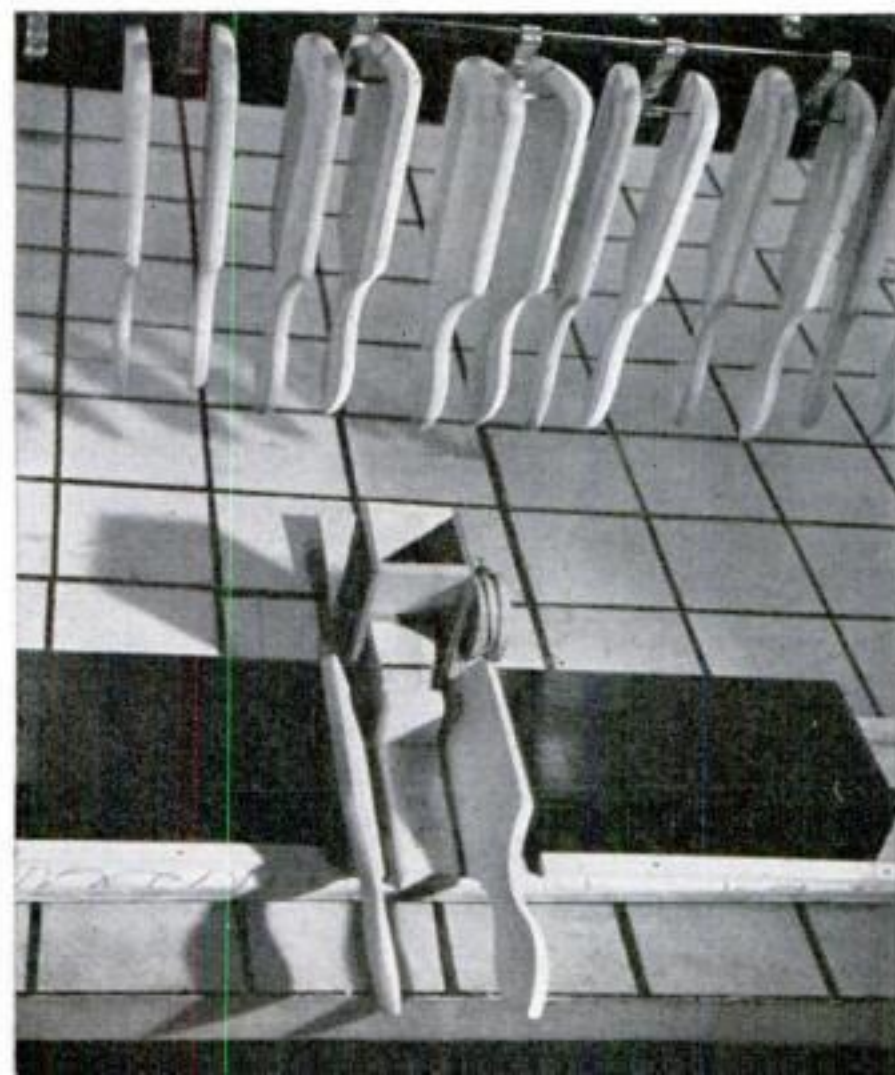
For dipping brush handles in lacquer, the Ox-Fibre Brush Co. used to have hooks laboriously driven in by hand. They sent George Hargis to Lake Placid

This feeds a double-pointed pin from the hopper below into a groove between the handles. A kick on the other pedal moves the black blocks together . . .



. . . where he developed this machine. Placing a pair of handles between two black blocks on the table, the operator of the device presses on a pedal

. . . driving one end of the pin into each handle. Springs pull the black blocks apart, the joined handles are hung on a hook, and new ones inserted



shorter time—a vital consideration today.

Republic Steel sent a man to the conference to find a better way of putting together cable clamps. He did. The new procedure he worked out will mean a 33-percent saving in the time required to complete the operation. This, in turn, will result in a 50-percent boost in production. While the man from Republic was achieving this advance, another delegate, representing Johns-Manville, was busy perfecting a simpler method for sorting iron washers, and a representative of the surgical supply house, Johnson & Johnson, was searching for—and finding—a time-saving improvement in

packing procedure that cut a product's cost.

A packaging problem also occupied the attention of the delegate from the Walter Baker chocolate company. By devising a double-tier supply chute, which delivers chocolate bars to the packers so they can use both hands without waste motion, this representative, Dale Marks, was able to step up the output of the packers 136 percent. Where five girls packed only 70 cases an hour, the new method enables three girls to pack 100 cases.

Frequently, substantial savings in time are chalked up without the introduction of any new apparatus at all. In one big east-

PREPARING A LENGTH OF AVIATION IGNITION WIRE, BY THE

START

This is the method formerly used at the Vultee Aircraft plant in Nashville, Tenn., in fabricating wire assemblies for military planes. First, cutting the wire to measure took a full minute's time . . .

2
MIN.

. . . then the insulation was stripped off the ends of the wire by hand with a pair of pliers, just as any householder would do in attaching a plug for an appliance. This consumed another minute



NOW, THROUGH THE USE OF WORK-SIMPLIFICATION METHODS,

START

Vultee's Joseph M. Druliner demonstrates the improved method he worked out for doing the job. He draws the wire through a meter that cuts it to desired length

12
SEC.

. . . and pulls it into an automatic stripper which removes the insulation from the ends. Work simplification has cut the time on these two jobs to 12 seconds



ern factory, where all machinery was supposed to be running at peak production, the output was stepped up 25 percent simply by eliminating waste motion through ideas obtained at Lake Placid.

Approximately five of the six weeks of the conference are consumed in completing all the individual projects brought for solution. As soon as a project is finished, it is filmed with a home-movie camera to provide a record and to aid in instructing workers back at the factory. Both the previous and the new methods are recorded so the person viewing the movie can see exactly how the change saves time and increases

output. By demonstrating the reason for the change in this way, better coöperation is obtained at the plant where the innovation is introduced. More than 300 other movies, each showing some improvement in manufacturing technique, are also available for study by the delegates.

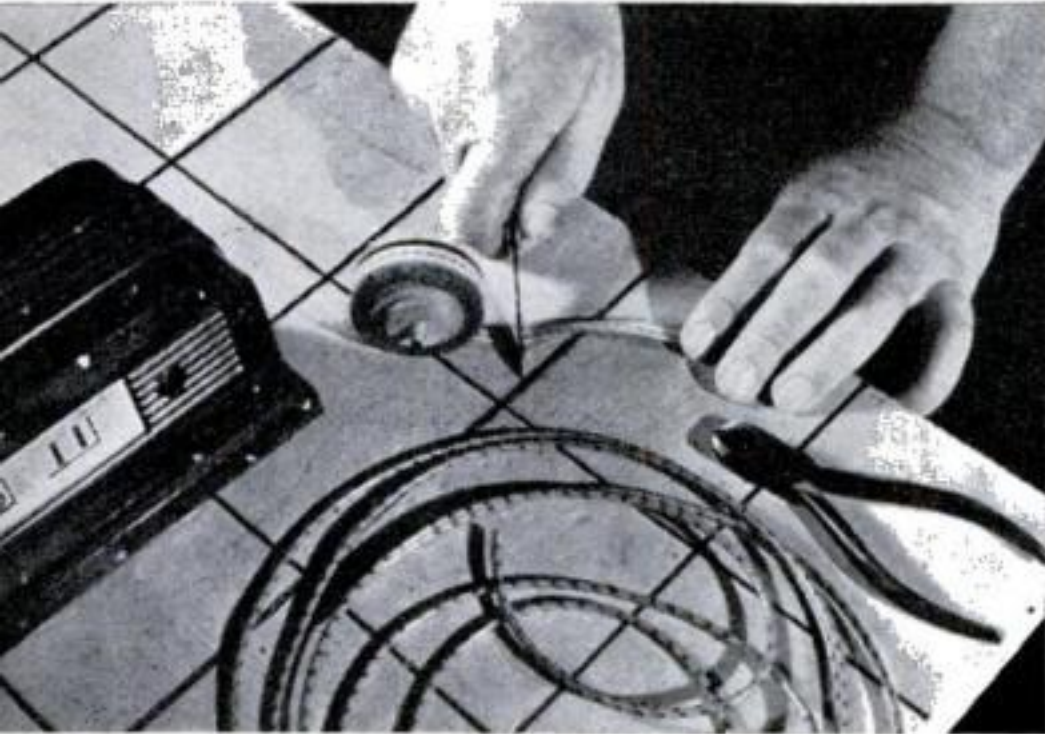
Scores of products, ranging from soap to firearms, have been hung on the walls of the conference laboratory. They are the unique trophies of a unique institution. Each is the product of a company that has obtained at one of the conferences ideas for saving time, cutting costs, and increasing production through work simplification.

OLD METHODS, TOOK AN OPERATOR A TOTAL OF . . .



Identification tape of gummed cellulose was cut by hand and wrapped around the wire. Such marking is necessary because there may be 100 different lengths and sizes in one plane. Another minute

Twelve seconds more went into putting the stripped ends of the wire in the terminal lugs. Then the terminals were squeezed tight. Total time required, five minutes

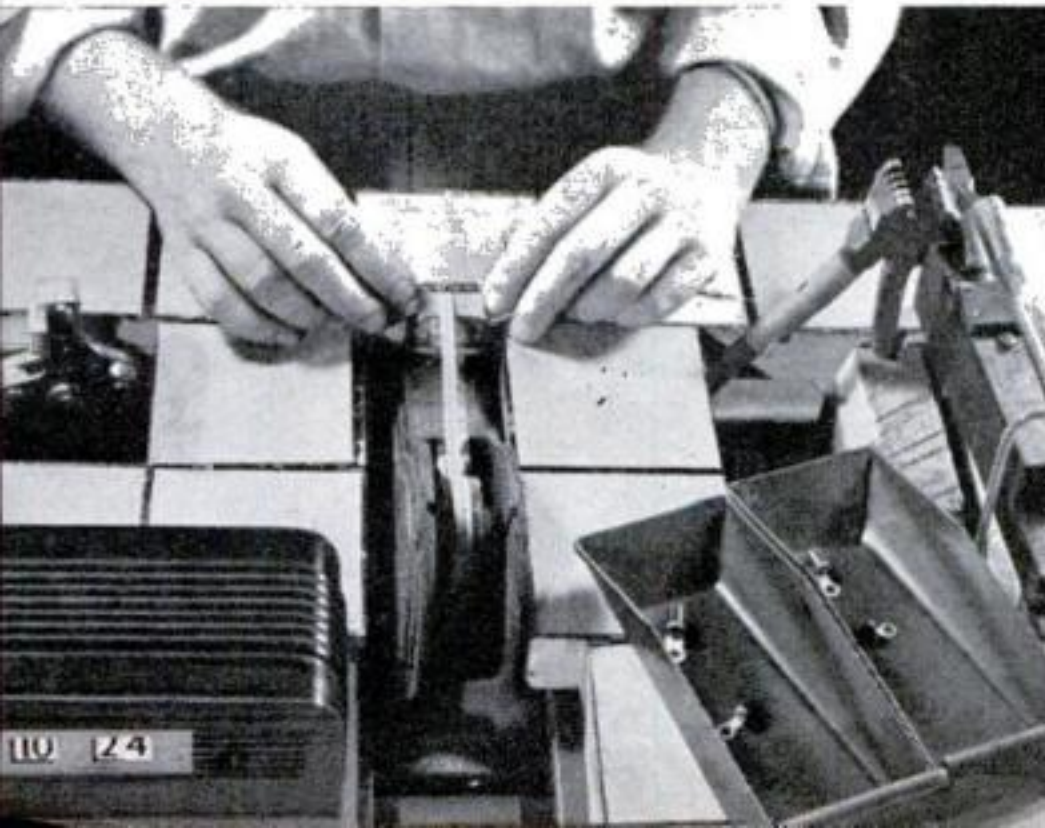


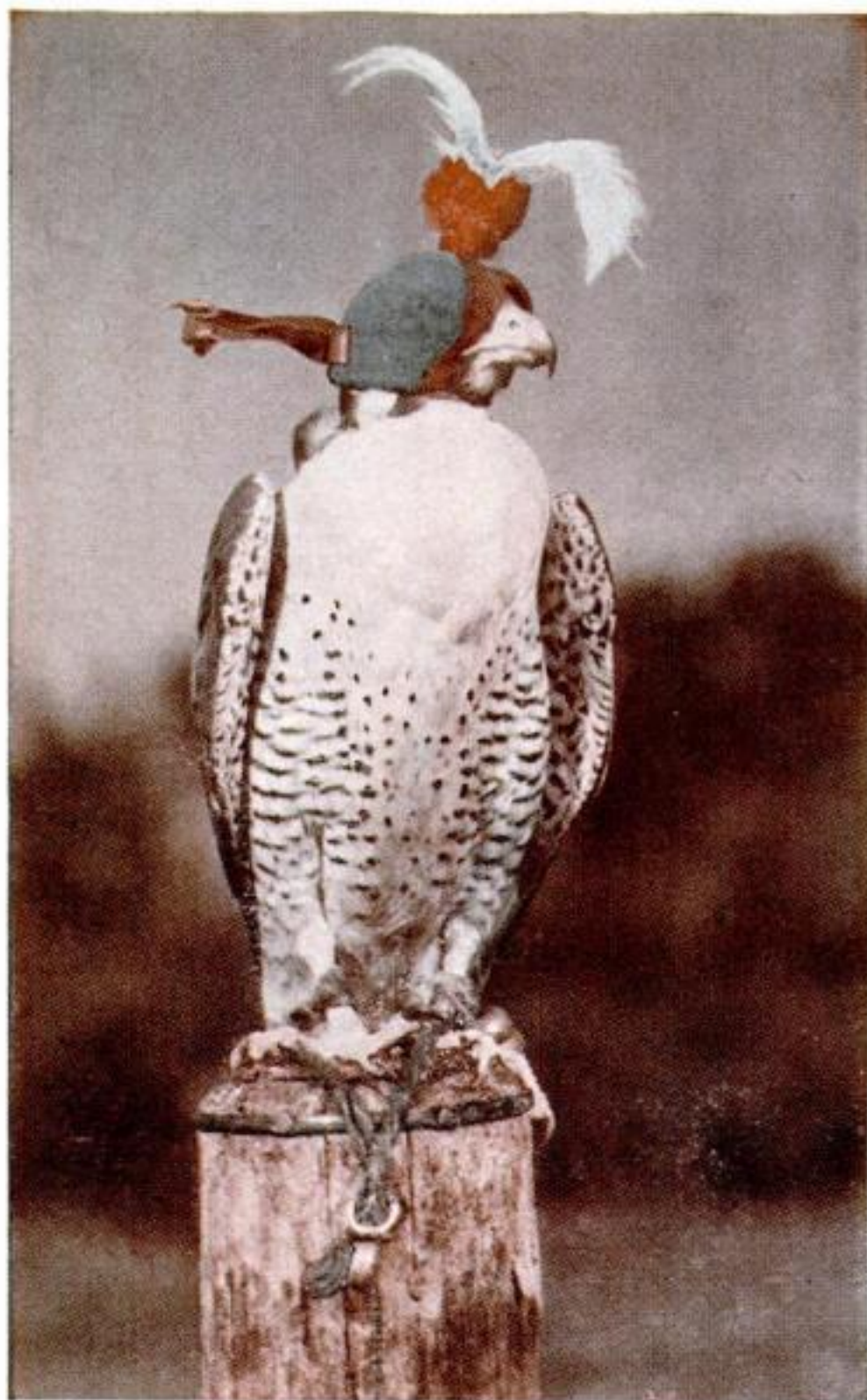
THE JOB TAKES THE SAME OPERATOR JUST



. . . and another 12 seconds goes into the task of cutting and winding the identification tape, which is done with a device that Druliner made for the purpose

Now the terminal lug is placed on the bare end of the wire and inserted in an automatic squeezer. Time required, 48 seconds





Falcons-

FEATHERED HUNTERS FOR MAN

**Sport of the Crusaders,
Unchanged for Centuries,
Lures Modern Americans**

By EDWIN TEALE

The American duck hawk—a true peregrine falcon—is one of the birds of prey being trained by sportsmen in the new revival of falconry. This bird shown sitting on the block used in "weathering"

HUNTING with hawks, a sport that flourished long before Marco Polo visited Kublai Khan, is now providing thrills for a growing number of Americans. In recent months, such organizations as the Smithsonian Institution, the American Museum of Natural History, and the U. S. Biological Survey, have received inquiries from all over the country on trapping and training falcons. More than 100 persons have joined the recently organized Falconers' Association of North America. By January, membership in this first nation-wide organization of its kind is expected to approach the 100 mark. Local falconry groups are now active all the way from New England to California.

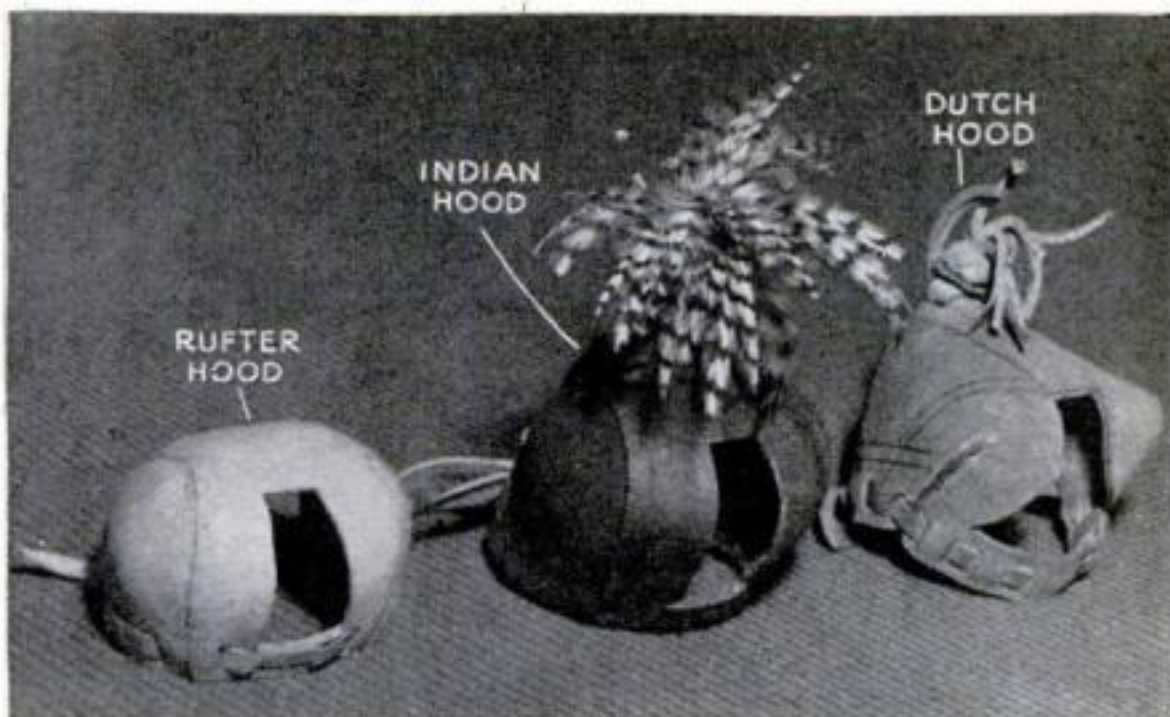
Under the direction of Capt. Russell L. Meredith, of Boonton, N. J., and the editorship of Dr. Robert M. Stabler, of the University of Pennsylvania, the F. A. N. A. is publishing America's first national magazine

on falconry. The initial issue of the publication, "The American Falconer," is just off the press. Each fall, the National Association will hold a tournament at which hawks from the U. S. and Canada will compete.

All over the world, hawks are divided into classes according to the shape of their wings. The short-winged hawks, such as the goshawk and Cooper's, pursue, overtake, and clutch their quarry. The long-winged hawks, including the peregrine falcon, the prairie falcon, and the gyrfalcon, plunge, or stoop, from a height and knock their prey to the ground with their iron-hard claws used as fists. A stooping peregrine is said to attain a speed of more than 200 miles an hour.

If a knight of the Round Table should visit our modern world, he undoubtedly would rub his eyes in amazement at the sight of tanks and planes and short-wave radios. But he would feel perfectly at home among America's growing band of falconers. For they are using the same methods, equipment, and picturesque language of the chase that have been handed down through the centuries.

Just as falconers did in the court of Wil-

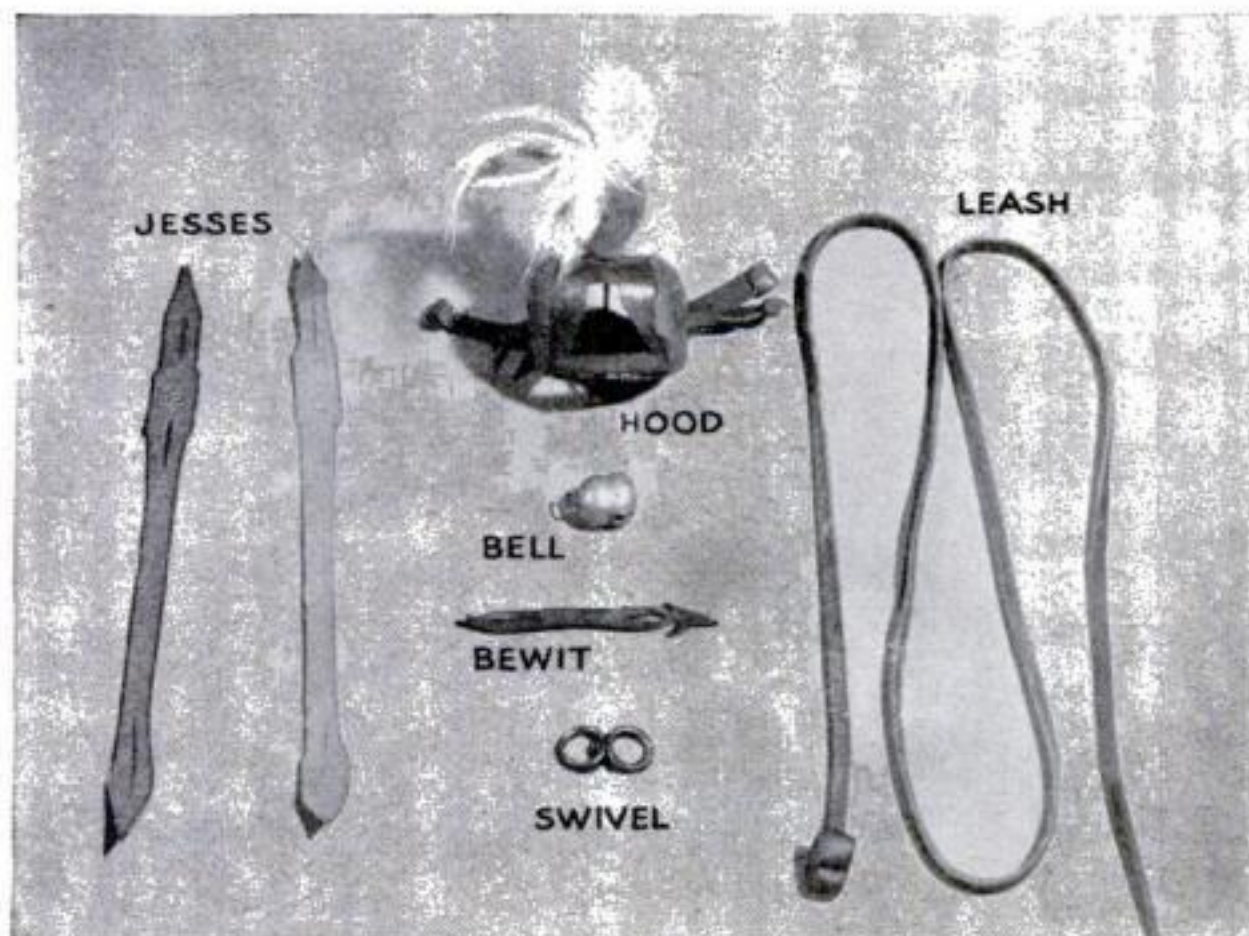


For centuries, these three types of hoods have been used to cover the eyes of hawks to keep them quiet when at rest. The unornamented ruffer hood is the one used in training the birds to hunt

At left, Dr. Robert M. Stabler, a prominent American falconer, demonstrates with one of his own birds how a falcon stoops to the lure, which is swung around over the falconer's head



The drawing at the right shows a falconer with all his paraphernalia ready for service. Below is the gear of the ancient sport, almost unchanged since ancient times





Cooper's Hawk



Prairie Falcon



Peregrine Falcon



Goshawk

FIVE KINDS OF FALCONS USED IN ANCIENT SPORT

Falcons are distinguished from other hawks by a notch in the upper mandible of the beak. Of the five kinds shown here, the Cooper's hawk and goshawk are short-winged hawks which clutch their prey in flight; these can work in cover. The prairie falcon, peregrine falcon (American duck hawk), and gyrfalcon are long-winged and knock their prey to the ground. The peregrine shown is an eyess, a bird taken from the nest, as distinguished from a passage bird caught full-grown.



Gyrfalcon

RINGING, or rising spirally from the falconer's fist, the hawk learns to wait on overhead until it sees the lure . . .

. . . to which a piece of beef-steak is attached. One type of lure is a horseshoe well padded and camouflaged with feathers

As the falconer swings the lure over his head, the hawk stoops to it. A well-trained hawk will speed to the lure from as far as it can see it



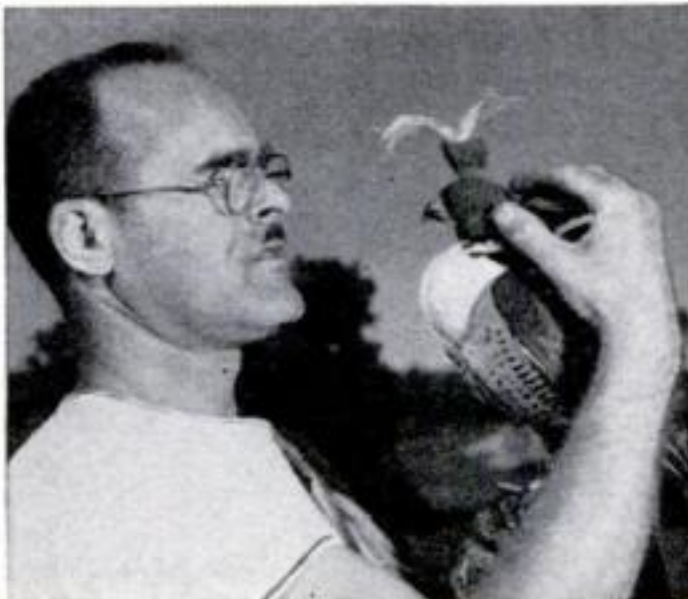
STROKING. During the early days of its training, the bird is kept hooded. As it is carried about on the gloved fist of the falconer, it is stroked frequently with the feathers of a dried pigeon wing or a wand as shown at the right. This calms the falcon's nerves and accustoms it to being handled. A low whistle or other sound is made by the falconer when the bird eats on the fist. Later, it will return to the glove whenever it hears the familiar signal



Putting on the hood with one hand while holding the hawk with the other takes practice

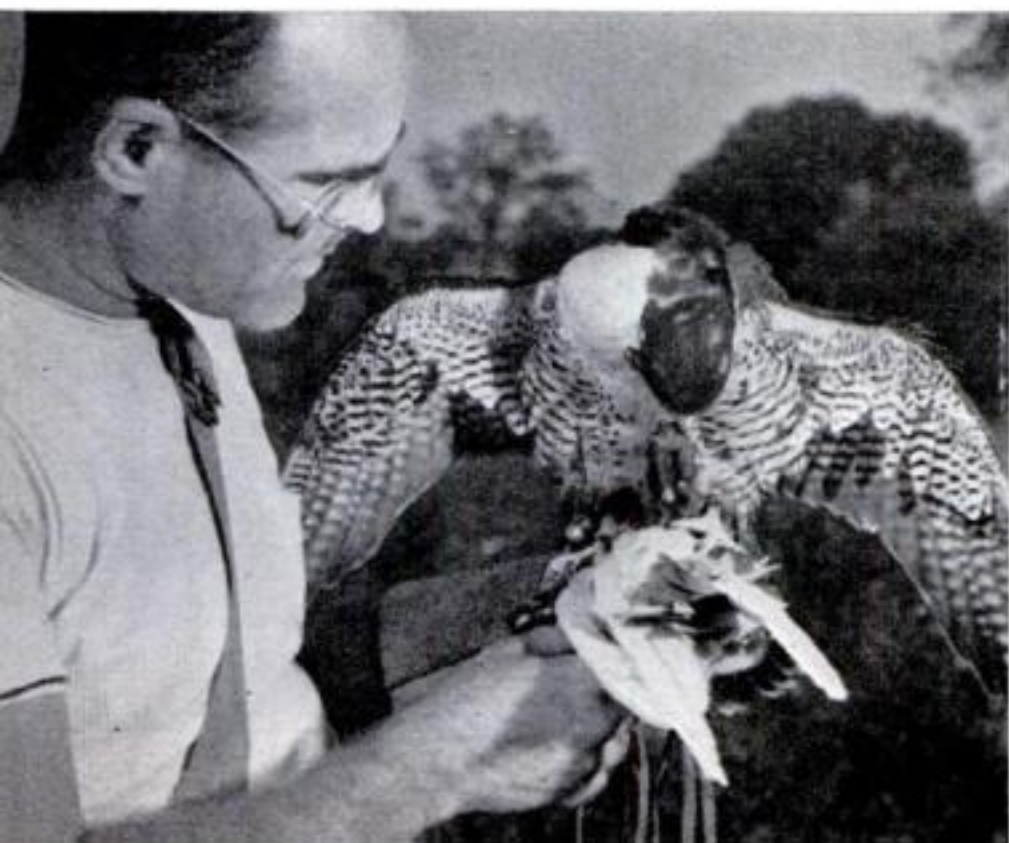
Pressing against the base of the longest drawstring with his index finger, the falconer pulls it tight

Now he pulls the other string with his teeth. To unstrike the hood, he just slips the strings



liam the Conqueror or Henry VIII, they secure the legs of their hawks with jesses—strips of leather which are, in turn, fastened by a swivel to a leather leash a yard or so long and ending in a button. Other straps

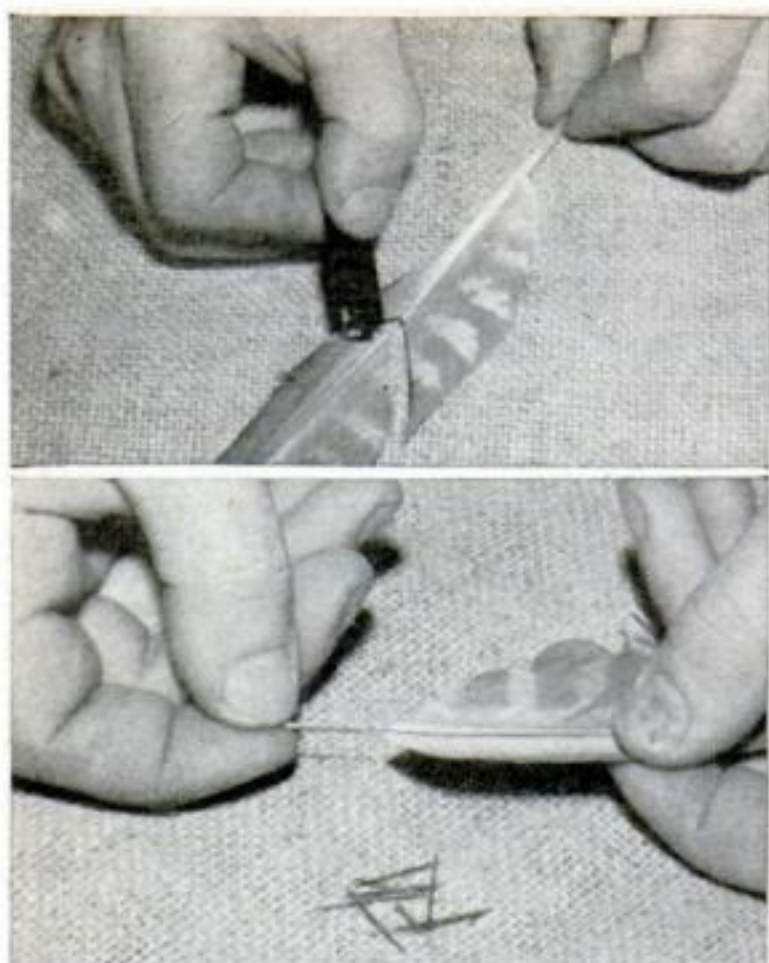
Feeding off the lure teaches the falcon to associate it with food. From time to time, birds are given tirings, or plucked wings of pigeons, to keep the beaks in condition



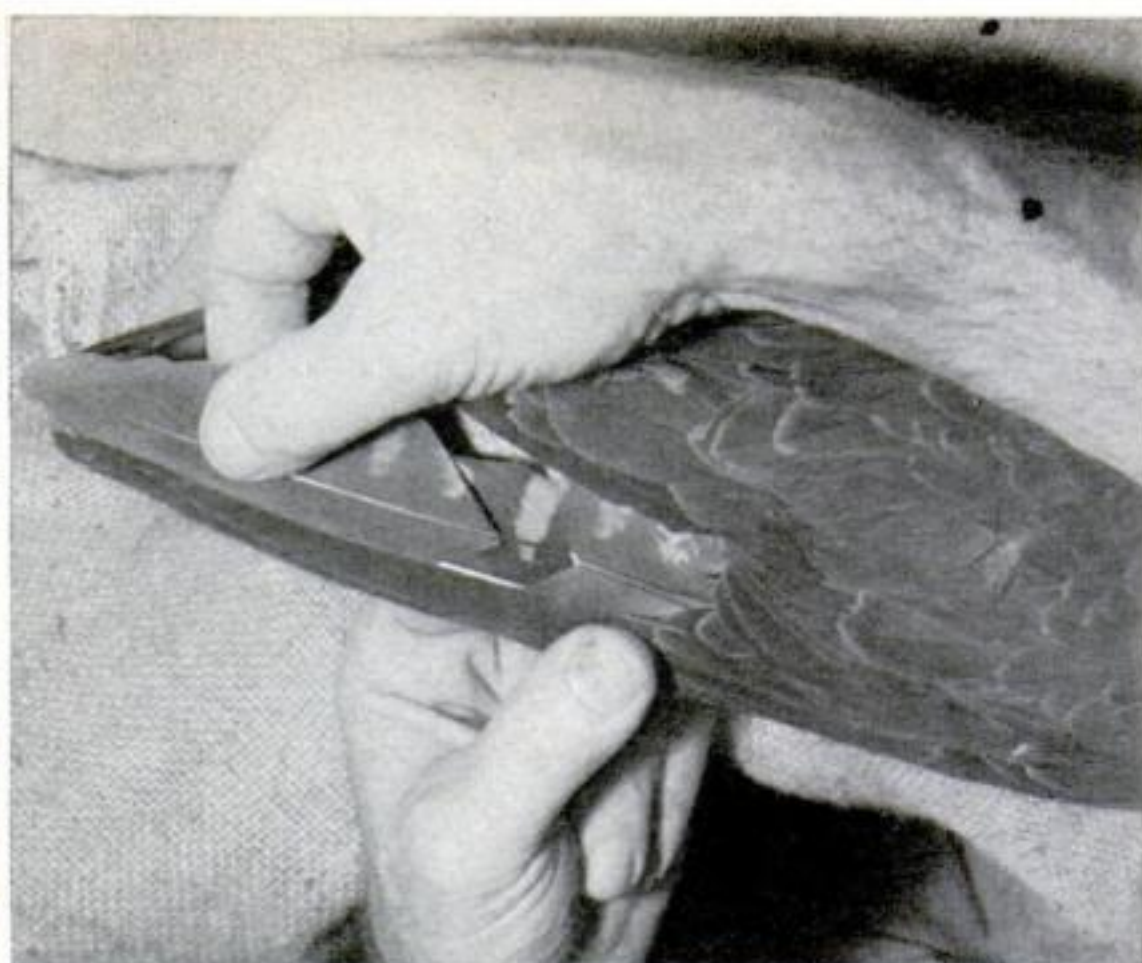
of leather, called bewits, secure bells to the legs of the birds. Bells, bewits, and jesses remain permanently on the hawks. Sometimes, varvels, rings of silver on which the owner's name is engraved, have been added.

To the falconer, a hawk's wings are sails; its legs are arms; its breast feathers are mail; and its claws are pounces. When a falcon grows tame, it is said to come to; when it is thoroughly trained it is well entered; when it is in good hunting condition, it is in yarak. The bird bates when she flutters off her perch; she rings when she rises spirally in the air; she mantles when she extends a wing and a foot simultaneously in stretching at her perch; she mews when she molts; and she foots well when she is successful in knocking her quarry from the sky. A bird as large as a grouse, struck at the end of a peregrine's stoop, sometimes hits the ground so hard it bounces fifteen yards.

To produce such hunting hawks, falconers use two types of raw material: birds taken



SPARE FEATHER. A broken wing feather is not allowed to impair efficiency. A replacement is cut from a spare and a pin is inserted in the shaft



When the other end of the pin is fitted into the shaft of the original feather, the wing is as good as new. Note the careful matching of the feathers

from the nest, or eyess falcons, and birds trapped by means of bow nets and decoy pigeons, or haggard falcons. To train the wild hawks, the falconers follow an age-old procedure.

During the early days of this training, the birds are kept hooded and, as they are carried about on the gloved fist of the falconer, they are stroked frequently with the feathers of a dried pigeon's wing to soothe their nerves. Feeding the captive hawks raw beefsteak—about five ounces of lean meat to a meal—or freshly killed pigeons, while they cling to the gloved hand, trains them to associate the hand with feeding. A low whistle or other distinctive sound is made by the falconer while the bird eats. Later, at the sound, the hawk will return to the fist. From time to time, tirings, or plucked pigeon wings, are given the hawks. They tear off bits of the meat, worrying the wings for half an hour at a time. This keeps their beaks in good condition.

When the birds are partially tamed, the hoods are removed and replaced by the falconer during feeding time until the birds become used to the procedure. Now, the hawks can be left unhooded outdoors in what is known as weathering. Sitting on cork-topped blocks of wood, they become accustomed to the sight of people and animals. An unhooded, or barefaced, hawk seems happier when there is some activity around it.

Advanced steps in training begin with teaching the hawk to eat from the lure. This is a flat object too heavy for the bird to carry and too soft to injure the hawk if

it stoops on it in the air. It is sometimes made of a horseshoe well padded with tow and covered with leather and feathers. Lean beefsteak, tied to the lure, attracts the hawk. First the bird is permitted to eat the steak on the ground; then the lure is swung about the head of the falconer and the hawk stoops on it. To train the hawk to wait on overhead, the falconer hides the lure after attracting the bird and makes it spiral around for longer and longer periods.

In falconry, two methods of hunting are used. In one, while the hawk waits on overhead, the falconers, often with the help of dogs, flushes birds from coverts below. In the second method, the hood is removed and the hawk freed when flying game is sighted.

This kind of hawking requires expert handling of the hood. In one method of fastening the hood, the falconer takes the longest drawstring on the left side between the thumb and middle finger of his right hand. Then, by pressing against the base of this drawstring with the index finger, he gives a steady pull with the thumb and middle finger, closing the hood. It is now easy for him to draw the other string tight with his teeth. Later, to strike the hood, he simply draws the strings and the hood is ready to be slipped off instantly.

The peak of interest in this sport came in the Middle Ages, when falconry was so popular that hunting birds were allotted according to rank. Kings got the eagles; princes the gyrfalcons; earls the peregrines; priests the sparrow hawks; and servants the useless kestrels.

Tanks CAN Be Destroyed

**Land Battleships
Meet Their Match
in Hard-Hitting
and Fast-Moving
New Gun Carriers
to Run Them Down**



DRIVER REMAINS AT POSITION DURING FIRING SO HE CAN SWING CAR AT TARGET

6-CYLINDER FORD IN-LINE ENGINE OVER REAR AXLE

GUNNER'S SEAT

SHIFT FOR FRONT-WHEEL SELECTIVE DRIVE

HAND BRAKE

The swamp buggy (motor carriage T-8) is one of the Army's new weapons against the tank

ARMOR-PLATE SHIELD PROTECTS GUNNERS

PIVOTED 37-MM. ANTITANK GUN

GUNNER'S SEAT

GEARSHIFT, 4 FORWARD, 1 REVERSE

AMMUNITION CONTAINERS

HIGH-FLOTATION TIRES—9.00 x 20

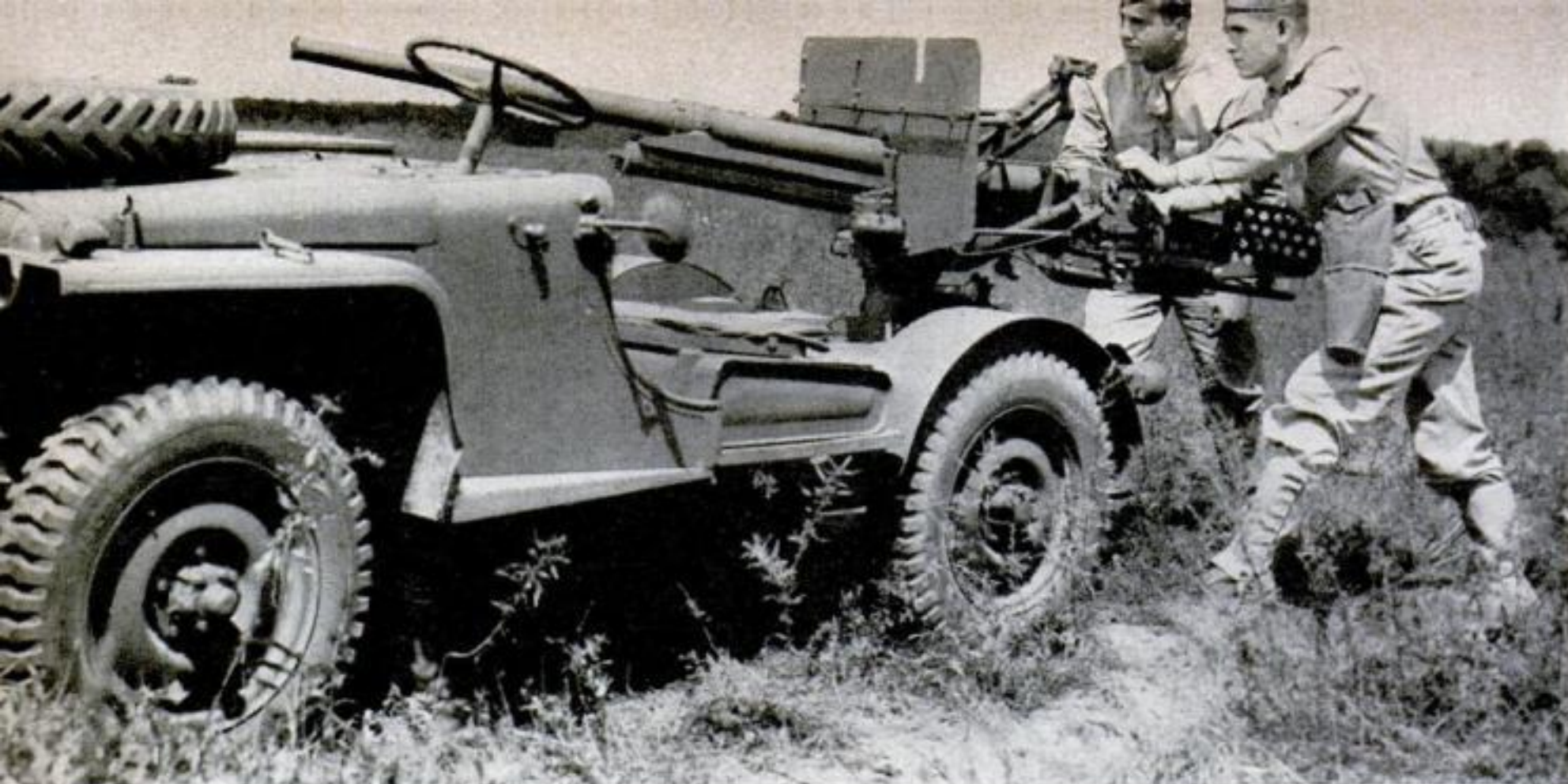
DRAWING BY STEWART ROUSE

By HICKMAN POWELL

WHEN America's mechanized columns clattered into battle in the recent war games of the armies, they encountered a new type of weapon and a new style of tactics which on more than one occasion gave their tank battalions a thorough kicking around.

Fast, inconspicuous, and powerful, firing from ambush and bursting forth in sudden surprise raids, came swarms of tank destroyers—armor-piercing guns on self-propelled mounts—which could outspeed, outmaneuver, and outshoot the heavy armored battle wagons lumbering down upon them.

Tanks can be destroyed. And the American Army is getting ready to do that job,



Carried by the famous quarter-ton reconnaissance truck (bantam car), this 37-mm. gun can be swung around on its swivel mount. Photos below show it aimed forward and to rear with the car in motion. The first mount of this type was made by Col. B. Q. Jones from an old Ford differential casing



As shown below, the muzzle of the gun can pass under the steering wheel when it is swung sideways



without waiting for factory production to put us on a basis of tank-for-tank equality with potential enemies. The new weapons for the purpose are simply ingenious adaptations of guns and carriers already available in vast quantities. The destroyer units into which these guns are being organized—with unprecedented mobility and concentration of fire power—are a purely American innovation in the art of mechanized war. They substitute an up-and-at-'em pugnacity for the old antitank practice of placing guns and waiting for an attack by the enemy's land battleships.

The basic heavy weapon of the new tank-destroyer units is the old 75-millimeter gun. The 75 is capable of stopping any tank—if it can get into position and fire quickly enough. But up to now it has been mounted on wheels and towed behind a truck with muzzle pointing to the rear. To move it, either into action or away, precious minutes

must be lost in limbering and unlimbering.

The 75's new tank-destroyer mounting—with muzzle forward, ready for point-blank fire—is on one of the Army's new armored half-track personnel carriers. The half-track truck, with steering wheels in the front and endless-tread tracks behind, can do 50 miles an hour on the highway and can move rapidly across country over terrain where a tank can go.

Thus mounted, with modern fire control permitting rapid aiming and firing by one man, the 75 becomes a most formidable destructive weapon. Indeed, it practically becomes a myriad of such weapons, for the half-track is *already* in mass production—coming off the assembly lines of three big truck factories.

That will permit its lavish use in concentration of fire, and the Army is preparing for that kind of use. The first provisional tank-destroyer battalion, for instance, was

This is another version of the 37 on a jeep. Set on a higher mount, it fires forward over the engine with a limited traverse. This car carries a crew of four men



A sub-caliber barrel inserted in the gun enables the crew to practice firing without wasting costly 37-mm. shells. This barrel fires .30 caliber bullets



given a complement of 36 of these guns. That is equivalent to the field-artillery power hitherto assigned to a whole infantry division! And if many are lost in battle, America can always make gun carriers a lot faster than any other nation can make tanks.

Junior partner with the mobile 75's is the 37-millimeter antitank gun, souped up for armor piercing and mounted on the new bantam cars (jeeps) and a still newer military vehicle known as the swamp buggy. Unarmored, save for light shields across the gun mounts, these light vehicles are to be used for flank protection of the 75's and for fast hit-and-run fighting. They are so small and of such low silhouette that they can be hidden in practically any patch of bushes. The idea is for them to operate as sharpshooters, ready to cut and run for new cover as soon as discovered.

The mounting of the 37 on the little jeep is merely one new angle on the myriad uses

of the tiny car. But the swamp buggy, known officially as the motor carriage T-8, is something new, with exciting qualities all its own.

The swamp buggy was developed as a cargo carrier, by the Ford Motor Company. It consists of little more than a platform, four big wheels, and an engine (the new Ford in-line, six-cylinder.) The whole thing stands less than four feet high, and most of this altitude is in the balloon tires (9.00 by 20) which are 38 inches in diameter. The engine rests over the rear axle, at the right, and driver and gunners sit beside it. The antitank gun is mounted all by itself on the forward deck, ready for instantaneous action. With wide selective range of power and speeds, it can pass almost any pleasure car on the open road and can ride its big tires over almost any kind of ground—including soft spots where a tank would bury itself. It is so low it can hide in a weed patch.

Before this past year, the obvious way of combatting tanks was to build better tanks and more of them. But as a result of the tank shortage a whole flood of Army ingenuity was turned loose and within a few months the basis had been laid for a whole new technique of tank fighting with self-propelled guns. Even now, before the quickly devised weapons have been provided to troops in any great numbers, it is obvious that they are only a beginning.

No one man or group of men is responsible for this development, but one example of the kind of creative work that went into it is the case of Col. B. Q. Jones. Colonel Jones, veteran of the Air Corps, was assigned last year to cavalry at Fort Bliss; and incident to his duties was the testing of that new-fangled little car, the bantam jeep. In the



A half-track personnel carrier makes a self-propelled platform from which a 75-mm. gun can be fired point-blank at tanks. For maneuvers, this unit is simulated by rolling a regular carriage-mounted 75 onto a truck, as shown at the right

process he developed an idea all his own.

Last February he took the rear end of an old Ford truck, cut the differential casing in two, and turned it into a mount for a 37-millimeter gun. Then he took out the rear seat of a jeep, and in its place he put the gun, so swiveled that it could fire in several directions from the parked car. At first, when shooting sidewise, the little car would jump about seven inches with each shot; but when the mount was cut down a few inches she stood solid, absorbing recoil in her tires. There was a lot of skepticism, of course, about so insubstantial a mount for an artillery piece. But when the Jones gun hit a gasoline barrel three times out of four, at a range of 500 yards, it certainly was not to be ignored. Colonel Jones went to Washington, assigned to G-3 of the War Department. There, in the Training and Operations Division, he found a whole group of men thinking along the same lines as himself.

Soon Ordnance came out with its own version of a 37 on a jeep. This gun sits on a higher mount than the Jones gun, firing forward over the engine. In rapid succession came the development of the half-track and the swamp buggy as gun mounts. Designs are being made for a heavier jeep, better to stand a heavy gun.

Rapidly also came organization of new



outfits to use the new weapons. Up to this time, the basic unit for protection against tanks had been the antitank company of each infantry regiment, charged with the local protection of its own troops. Last July, after a four-day pow-wow of antitank men, the War Department embarked on the formation of 23 provisional antitank battalions, designed for the protection of larger units. Drawing on its own field artillery, each infantry division formed such a battalion. Nine still stronger battalions, for the protection of army corps, were put together from the field-artillery brigades, and instructed to work together in groups of three ready to take the initiative against any strong enemy armored column.

The new guns weren't ready yet, but soon old-fashioned 75's were hoisted into 2½-ton

trucks and lashed down with muzzles pointing forward. In other trucks, pine logs were set up as simulated guns. While waiting for armament, the battalions went to work on tactics. A whole new structure of antitank defense and tank destruction had been superimposed upon the Army,

At the base were the old antitank companies, the same as they had always been. Then each division had its provisional antitank battalion. In a square division this consisted of two batteries of 12 37-millimeter guns and two batteries of 75's, with eight guns each. In addition the battalion had a company of engineers, equipped with thousands of mines to be strewn thickly in the path of probable tank attack. This divisional antitank battalion, numbering about

475, has the function of protecting its own division from any mechanized break-through, after the fashion of halfbacks on a football team.

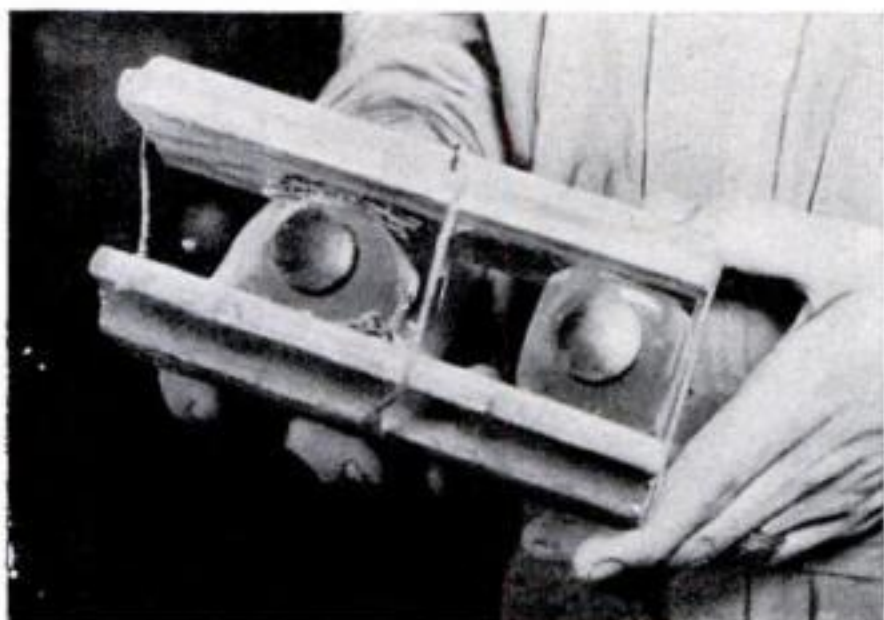
The antitank battalions from the field-artillery brigades, organized in GHQ groups and armed entirely with 75's, were assigned the more aggressive role of seeking out and combatting any major mechanized attack.

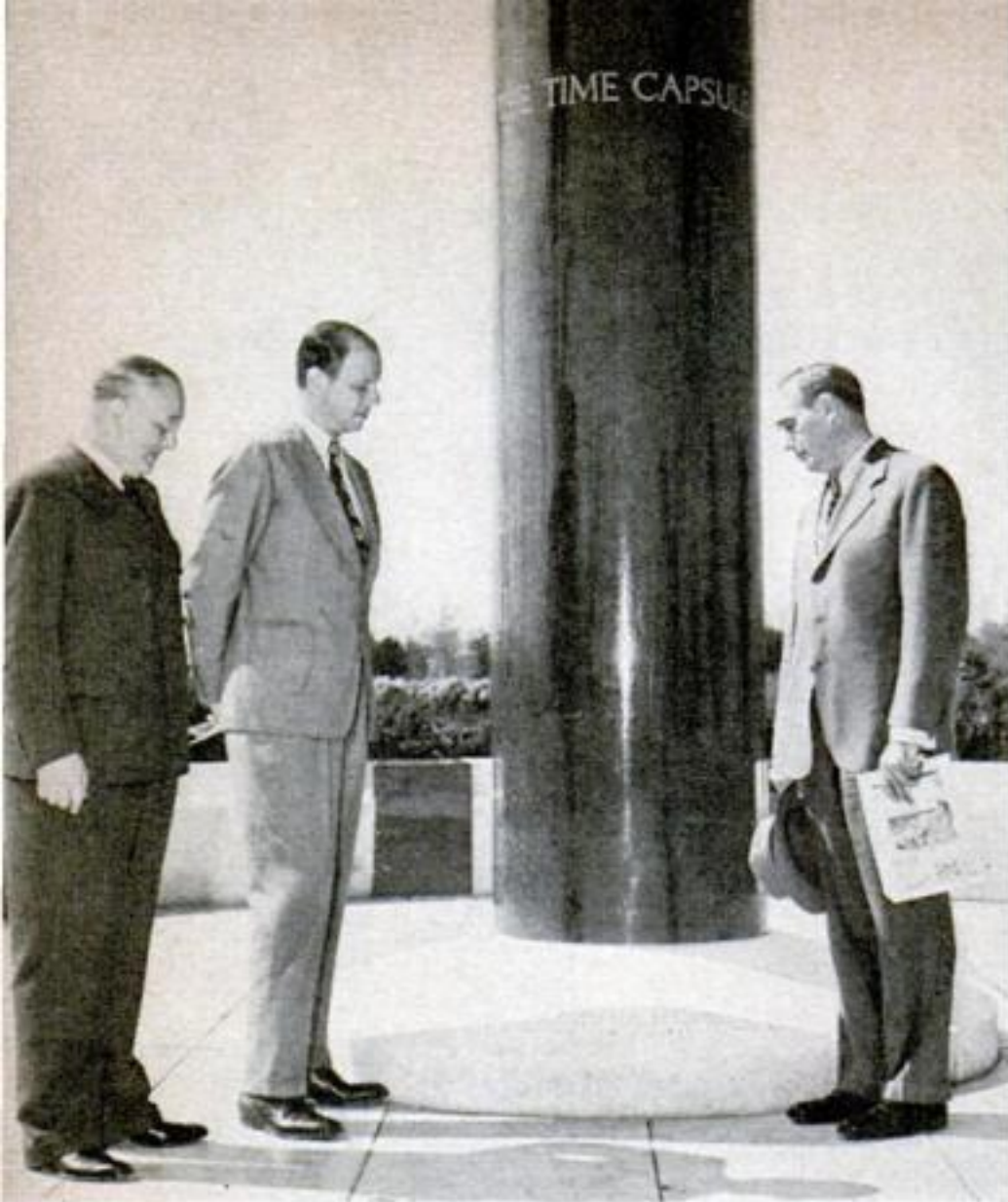
Then, on top of all this, came the General Staff's real innovation, the provisional GHQ tank-destroyer battalion, of which it is planned to mobilize a large number. Note that it is not "antitank." The whole philosophy of antitank tactics in the past has been to meet the enemy when he attacks. The whole idea of the tank-destroyer outfit is that it shall go out *(Continued on page 220)*



Mines, too, are poison to tanks. Here a truck is striking a make-believe mine planted by the "enemy" in maneuvers. Any tank or vehicle that hits one of them is marked down by the umpires as "destroyed"

Dummy tank mines consist of bottles of chemicals wired together between boards. Planted inconspicuously on the field of action, they produce puffs of smoke when crushed under wheels or tank treads





Granite Shaft Guides Diggers of 6039 A.D. to Time Capsule

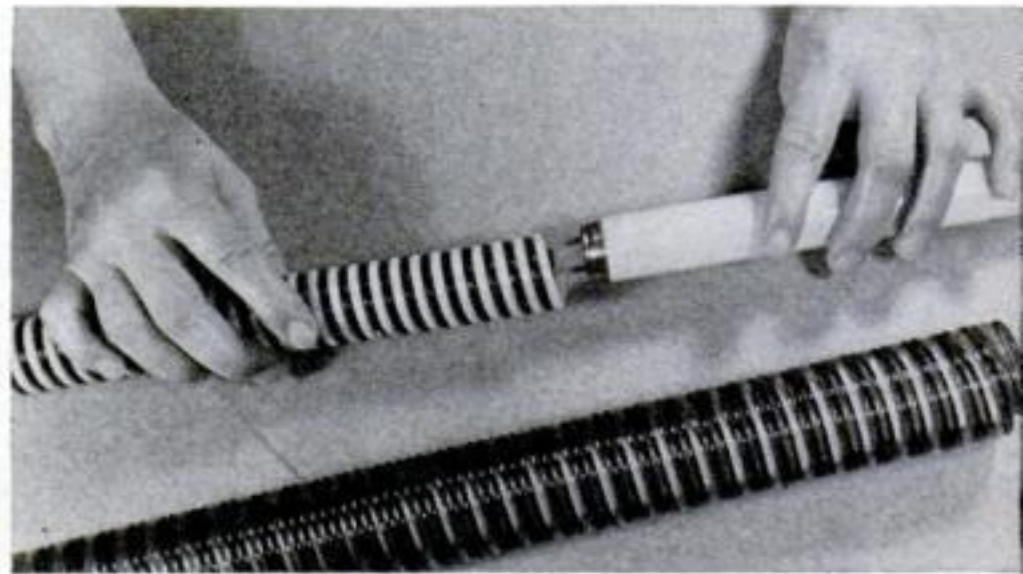
A BLACK granite shaft, recently erected at the site of the New York World's Fair, now marks the location of the Time Capsule, the 800-pound "letter to the future" buried September 23, 1939. Fifty feet beneath the shaft, the metal cylinder contains familiar objects in use today and microfilm recording 10,000,000 words of printed matter. The shaft will indicate where people in 6039 A.D. can dig for the capsule.

New Alloy Improves Tin Foil

GREATER strength and increased immunity to chemical reaction with foodstuffs are provided by a new kind of tin foil produced by scientists at the Tin Research Institute, in England. The new material is formed of an alloy made up of 91.35 percent tin, 8.5 percent zinc, and 0.15 percent nickel.

Plastic Coils Temper Light from Fluorescent Tubes

SPRINGLIKE coils of plastic material now control the character of light given off by fluorescent tubes. Ordinarily blue, yellow, and green rays predominate. By slipping on a coil in which red and white strands alternate, red rays are added to the light. The coils are expected to have special value in beauty parlors, clothing stores, and meat markets, for accurate judging of color.



Insects Go on the Air from Miniature Broadcasting Studio

BUILT on the same principles as a real broadcasting studio, a miniature soundproof room, only ten inches by ten inches, recently enabled officials of the Bronx Zoo, in New York City, to broadcast sounds produced by grasshoppers, crickets, centi-

pedes, and spiders. The single microphone on the floor of this insect studio picked up even such tiny sounds as the swish-swish of a centipede's legs. Five square feet of acoustical material went into the construction of the soundproof box.

Earle Chace, curator of insects at the Bronx Zoo, coaxing one of his temperamental pets into the "studio." Below, a tarantula gives all to the mike





MODERN TROOP TRANSPORTS ARE Seagoing Combat Units

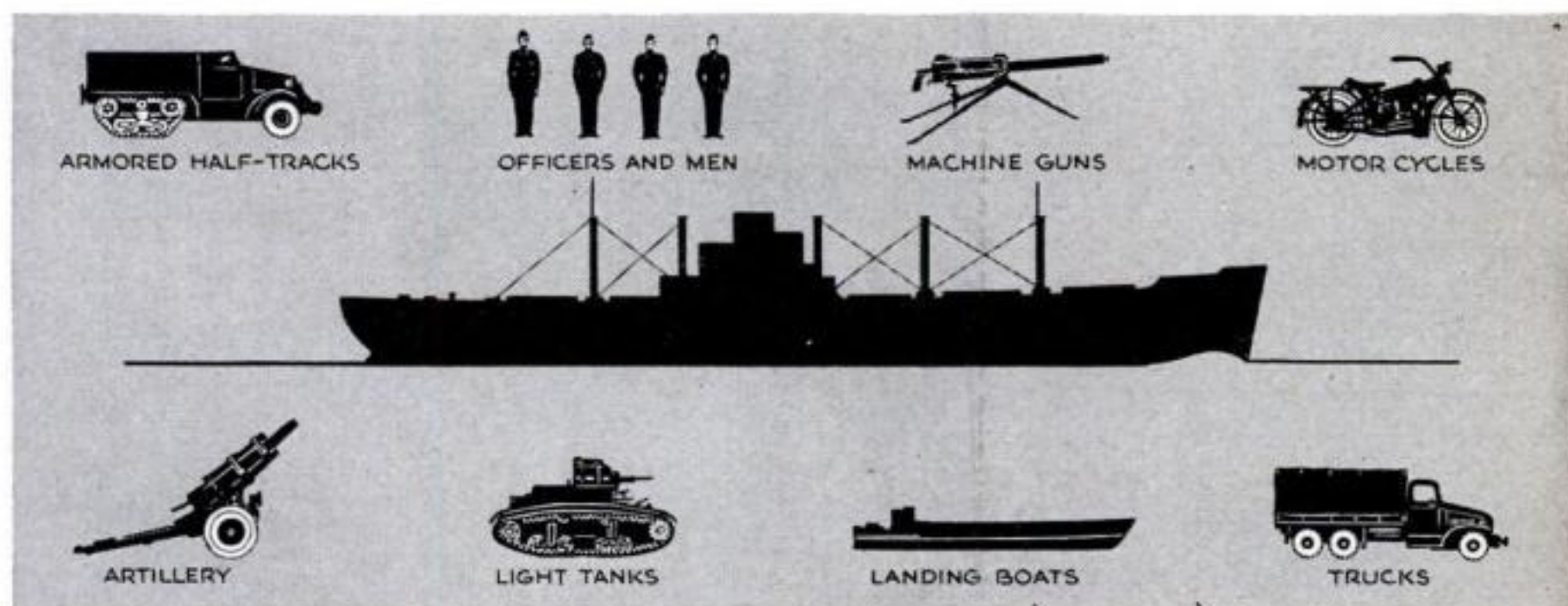
THE nation's armed forces have perfected a new system for the sea transport of American troops. Every troop-carrying ship will become a fighting transport bearing a self-contained combat unit, fully equipped and with each man in fighting gear and trim, ready to do battle the moment it is landed. The new method, which depends upon the fullest coöperation between troops and crew, has been tested in simulated invasion landings on American shores.

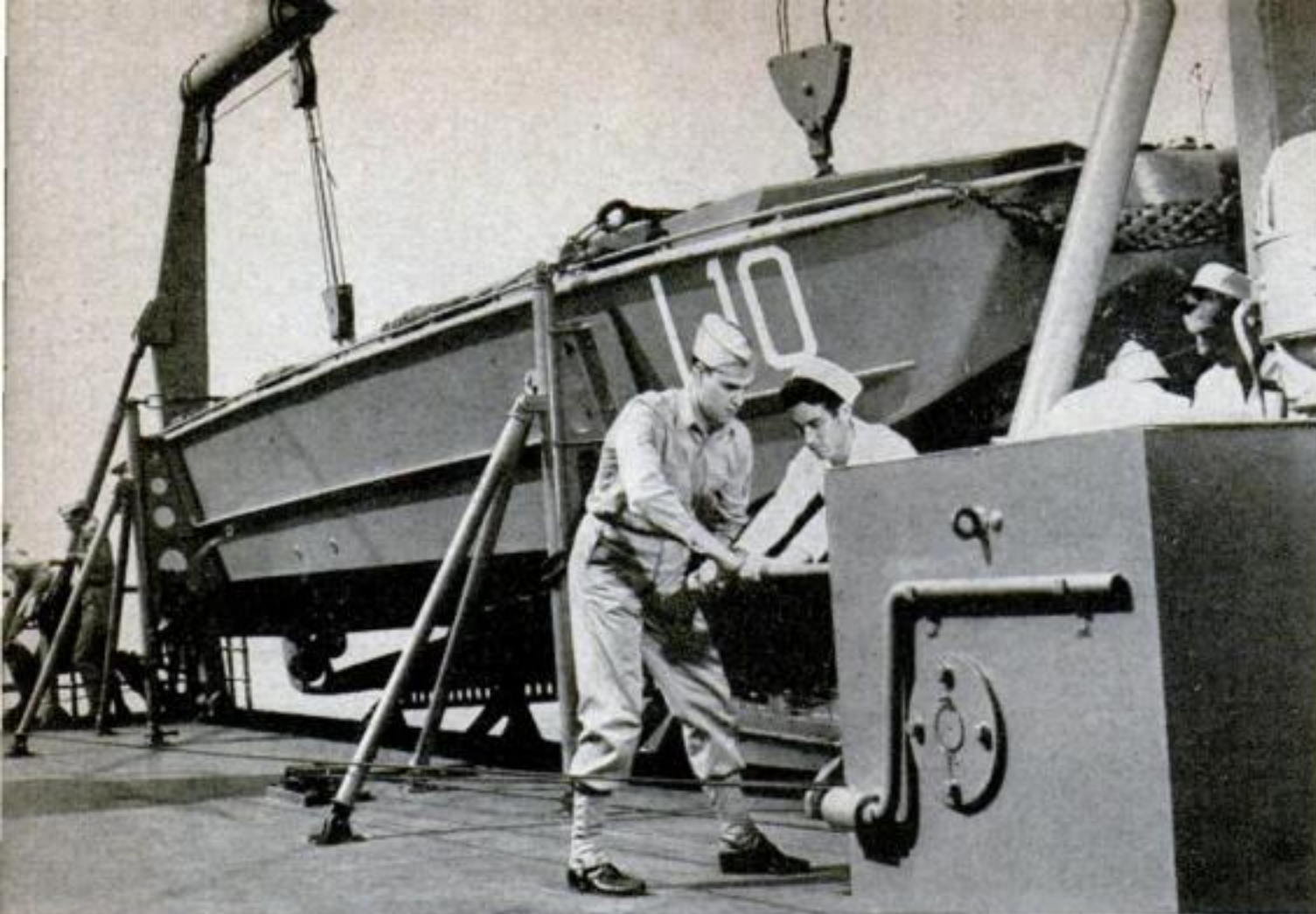
The new transport concept differs sharp-

ly from that used by the United States in World War I, when 2,000,000 troops were carried across the Atlantic on American and British troopships. Men and equipment were dumped casually aboard the transports then with little regard for their eventual use.

This hastily prepared transport plan was effective in 1917-'18, when there was ample opportunity to unscramble the cargoes of the vessels when they were deposited safely in Allied ports on the other side. But it seems

New loading system makes each transport a self-contained fighting force with all material and equipment

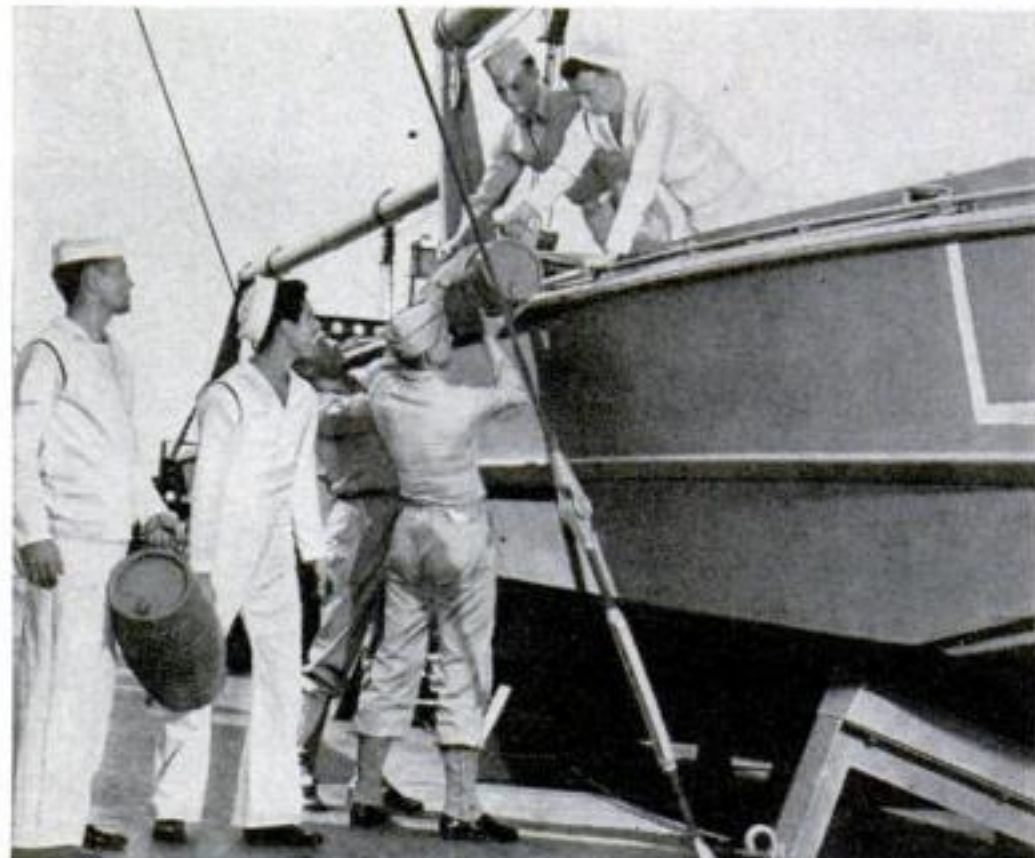




Landing boats for use in landing troops are stowed like lifeboats on each transport and are launched by means of davits. A landing boat like this takes men and equipment enough to hold a beach head. Larger landing boats carry more men and also ferry light tanks, guns and cars

Soldiers and sailors join hands at cranks that swing a boat over the side. Powered by gasoline or Diesel engines, boats can run up on a beach

Food and water are stored in the landing boats. If enemy action makes it necessary to abandon ship, the landing boats are used like ordinary lifeboats

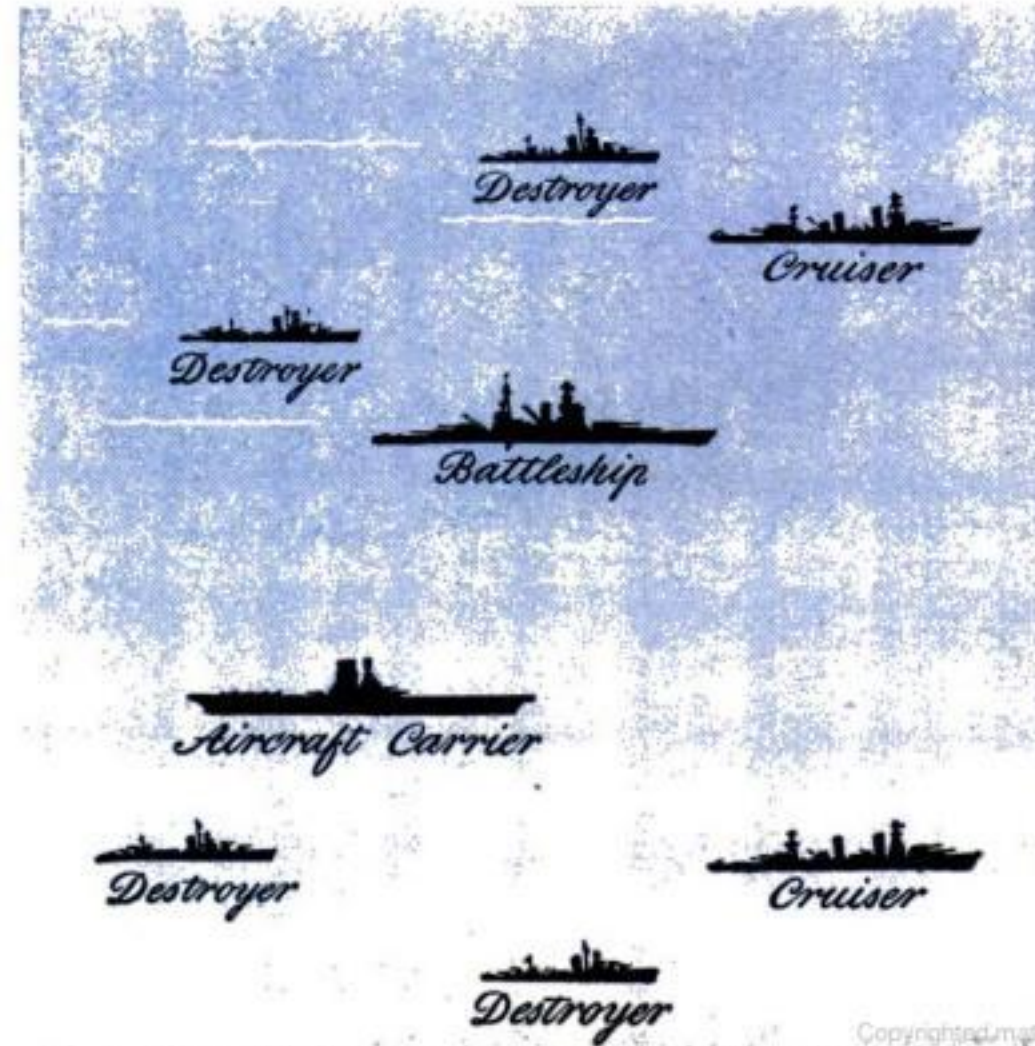


obvious that the same system would not work now.

In fact, this type of loading did not work in World War I when Sir Ian Hamilton tried it to land an Allied force at Gallipoli. His troops, inadequately equipped and poorly organized to invade an enemy-defended shore, were forced to withdraw.

It is possible that an American force sent on a combat mission in the present world situation might not find a friendly shore on which to effect a landing. Hence the new fighting transport was devised and made standard practice. It is simply an adaptation to the sea of the land combat unit which has been perfected.

One of the valuable American lessons of the first World War has been observed in



the new transport tactics, however. The result is that most transports, whatever their load or destination, are operated by the Navy with Naval officers in command. Whether the troops are soldiers or marines, the Navy is in authority while the transports are on the high seas.

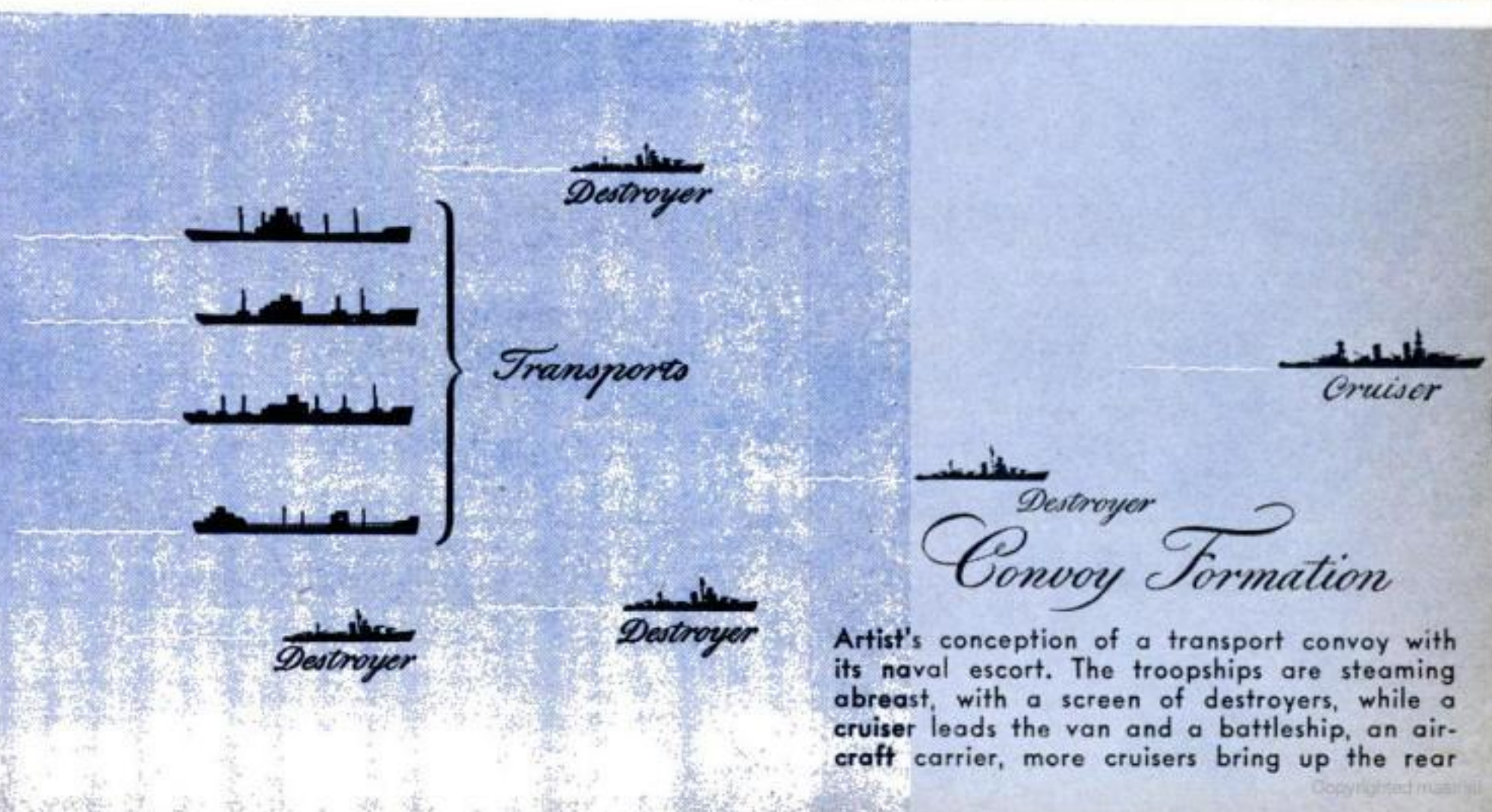
Not only are Navy officers in command, but the transports are manned by naval ratings. Furthermore, although there is little chance they will ever be landed for fighting ashore, the Naval personnel on a transport is considered part of the vessel's combat unit. The sailors might be used, for instance, to operate the landing boats which place the troops ashore.

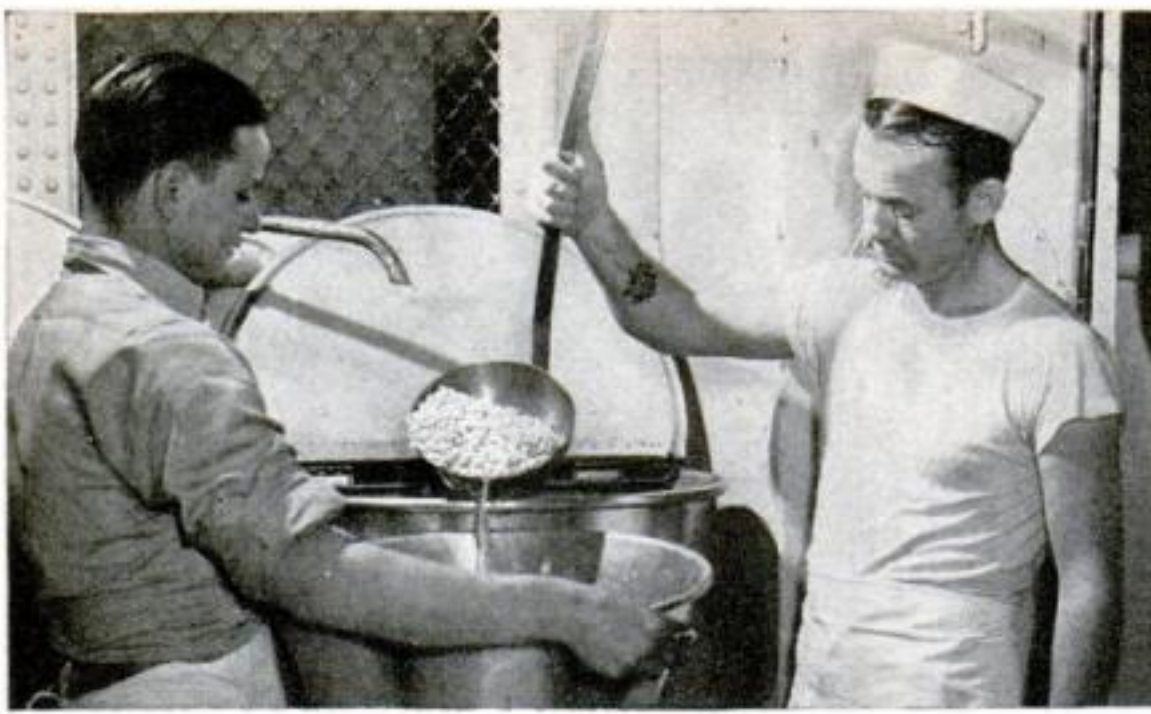
At present there are three types of transports. The first class consists of former Army transports which have been taken over and are being run by the Navy as regularly commissioned Navy ships. The second class is made up of vessels which have been built or bought by the Navy, which operates them to carry troops. The third class consists of ships operated under Army supervision with civilian captains and crews. Some transports of the third class are being taken over by the Navy.

Before the United States entered the war against the Kaiser, the Army administered all its own transport service. The crews were recruited from the merchant service. In 1917 our troopships in a submarine-infested ocean were convoyed by the Navy.

Coöperation between the two branches, an absolute prerequisite in modern war, has

Holds of the transport are veritable floating barracks. Each man has a berth, under which he slings his life preserver, rifle, and other equipment. He also has a locker for his clothes. Troops are made as comfortable as possible, as they may have to live aboard ship for weeks or even months at a time





FOOD is prepared three times a day in large galleys and is served out to troops in cafeteria style. The men eat at long tables which can be lifted out of the way, as seen below, to clear the space when they are not in use. Compactness is the keynote aboard modern fighting transports. Guns, vehicles, and other equipment must be carried as well as men



eliminated possible difficulties over the problem of divided authority.

On a recent visit to a port of embarkation some transports were on hand which had been refitted to carry troops. The ships have been arranged structurally to carry a combat team each as an expeditionary force. The loading is done to make each ship a fighting transport, with each vessel carrying a self-contained combat unit. All supplies and equipment for this force are loaded on each ship.

Tanks, artillery, machine guns, armored cars, trucks and motorcycles, and other equipment sufficient for the unit are stowed in the holds. The troops are allotted berths in the holds, each man having a bunk and locker for his clothes.

These transports are veritable floating barracks. Almost every convenience that obtains ashore is provided on board the ship. Large galleys or kitchens supply the food which is served out on the cafeteria system three times a day. Wash rooms, showers, barber shop, canteen, tailor shop, all add to the comfort and convenience of the men.

The health of the troops is an important task for the doctors. On each ship there is

a large sick bay or hospital where daily sick call is held, inoculations given, and medical treatment provided. There is a dentist and dentist's chair and a complete outfit of dental instruments to care for the men's teeth.

The most up-to-date system of communications is provided each ship. Radio rooms are complete. Blinker lights, signal flags, and hand flags are resorted to when at sea for intership communications. Radio silence is observed at sea for safety's sake, for a lurking submarine can locate a ship by radio direction finder.

Stowed on board each ship are a number of landing boats to be used to transport troops to shore. Some are gasoline-engined and others have Diesel engines for propulsion. They can be run up on shelving sandy beaches and the troops unloaded. Each boat carries a small unit of men with equipment enough to hold a beach head. In addition to these smaller landing boats, larger boats are provided each transport that are capable of carrying a light tank and landing with it on the beach.

Let us follow a theoretical expedition of transports to sea. The transports are loaded and leave the dock. Before leaving the har-



SICK CALL. Health of the troops is the care of the ship's doctors. In the sick bay, or ship's hospital, inoculations are given and treatment is provided for any illnesses that may develop among the many men aboard

GOING TO THE DENTIST is one of the less pleasant advantages offered aboard a transport. Each ship has a dentist's chair and a complete outfit of instruments. Among the more popular facilities are wash rooms, showers, barber shop, canteen, and tailor shop



bor they are joined by a naval escort of a size depending upon the opposition to be expected. It might have one battleship, several cruisers, six or eight destroyers, and an airplane carrier, if air opposition is apparent. The transports would be formed in line abreast, and the speed would be that of the slowest ship of the group. The battleship and aircraft carrier would take station astern of the transports, with a cruiser ahead and on the flank. The destroyers would encircle the ships and guard against submarine attacks.

On being attacked by submarines, the destroyers would lay depth-charge barrages. If a transport is torpedoed and sunk, the expedition would proceed as planned, for the unit sunk would merely reduce the force. No essential material that would be needed for the expedition would be lost. Of course, the troops would be rescued by the destroyers and escort vessels. This method of loading the transports, by which they are self-contained in material and equipment, not only preserves the integrity of the expedition in case of casualty, in not losing some particular equipment that might be essential to the expedition, but also makes the group

flexible in that a transport can be picked out of the group and sent off on an eccentric mission, and be capable of landing its force with all of their equipment.

These transports have been converted from merchant ships, mostly cargo vessels. An attempt has been made to make the lot of the soldier on these transports as comfortable as possible, for the troops on each ship may be forced to live on board the transports for many weeks if not months before being landed.

The crew of the transport and the troops are trained to work together as a team. The troops are available as guards, lookouts in crow's-nests, as crews of boats, as cooks in the galleys, and to serve out the food. Only the work appropriately belonging to the sailor is performed by the crew of the vessel; practically all else is performed by the troops.

One of the most important drills is that of bringing on deck the entire crew and the troops to the vicinity of the boats when danger threatens. When the alarm sounds all hands proceed to their stations for "abandon ship." Booms are rigged out for hoisting out the *(Continued on page 220)*

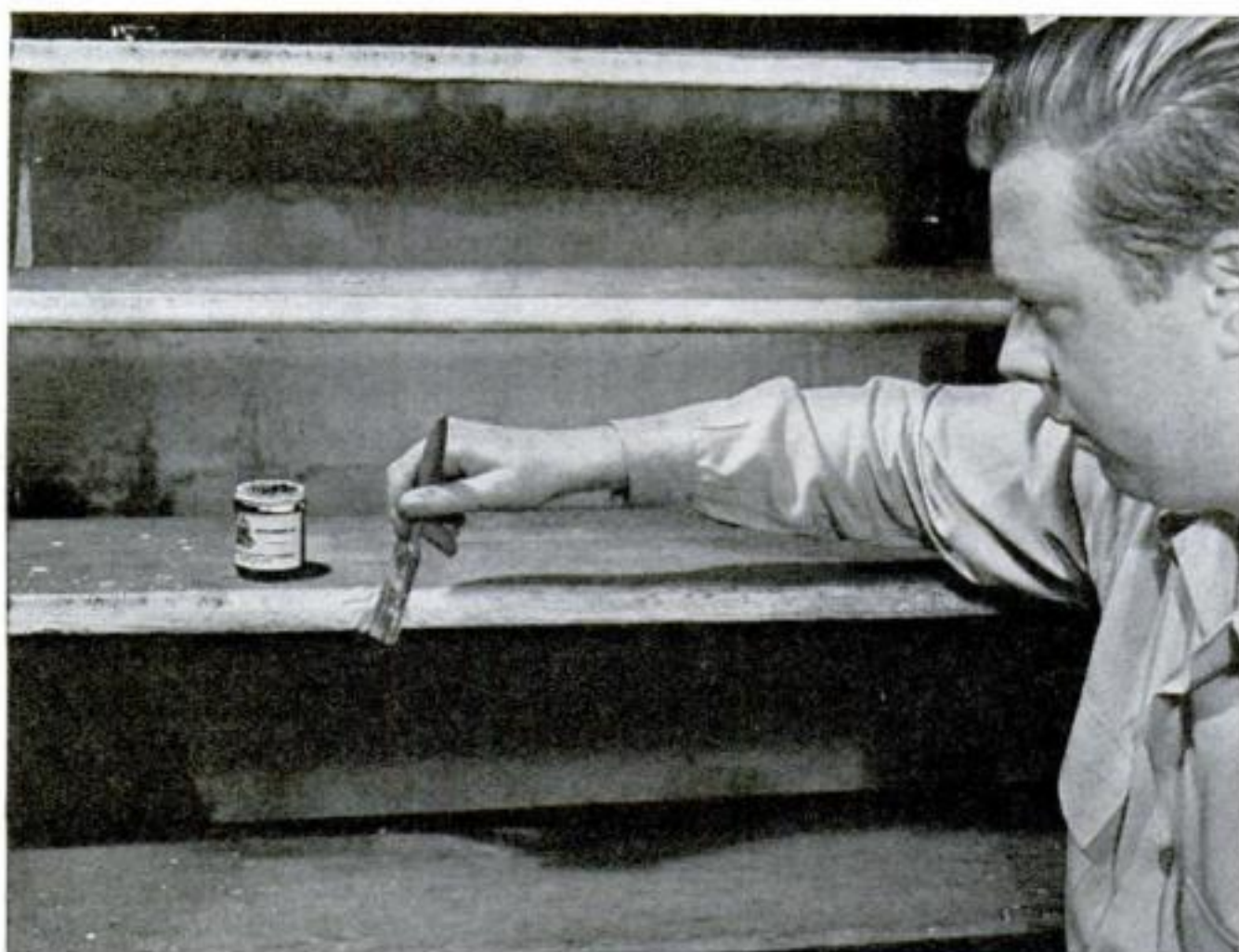
LIGHTING WITH PAINT

New Luminous Coating Has Many Practical Uses in the Home

LUMINOUS paint of improved composition, especially developed for practical purposes rather than as a toy or dramatic stunt, now makes house numbers, doorknobs, keyholes, and bedroom slippers easy to find in the dark. It marks danger spots such as stair treads and electric fans. Besides these household uses, it may be employed on highway markers, boats, docks, and buoys. The newly marketed cream-colored paint, after brief exposure to daylight or artificial

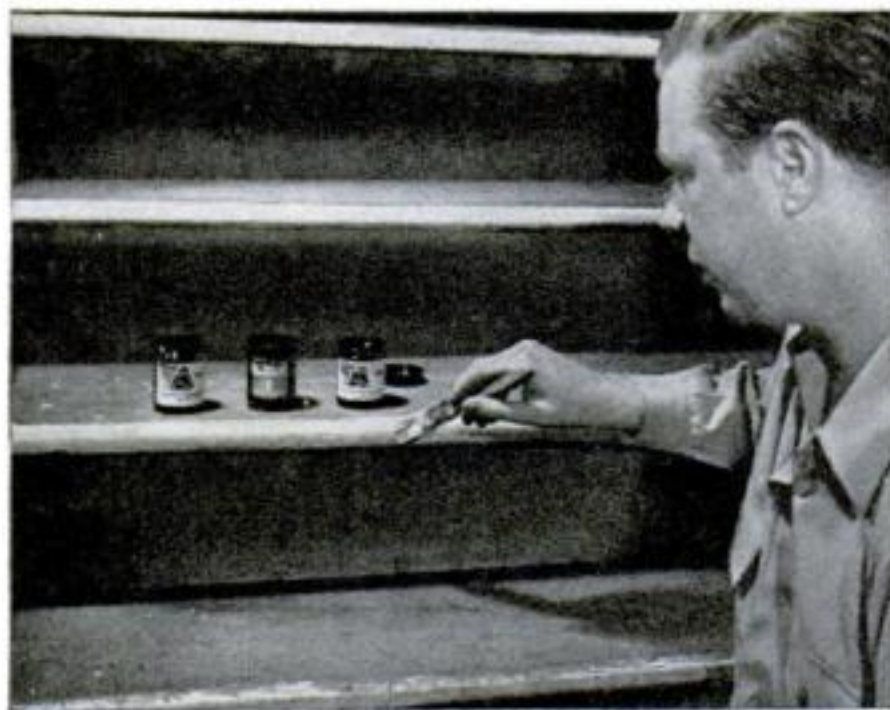
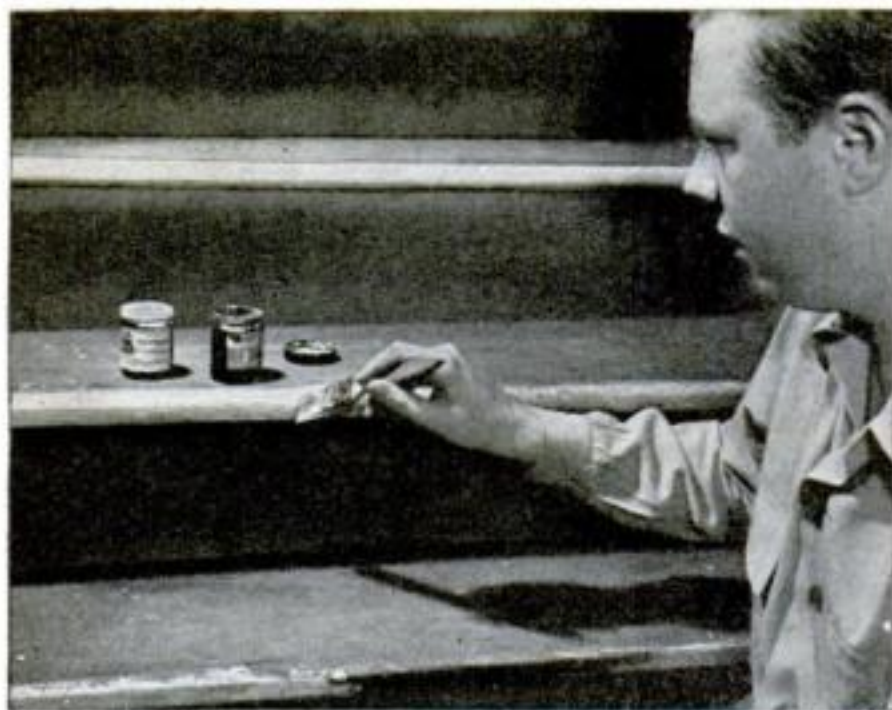
illumination, emits a soft blue-green glow.

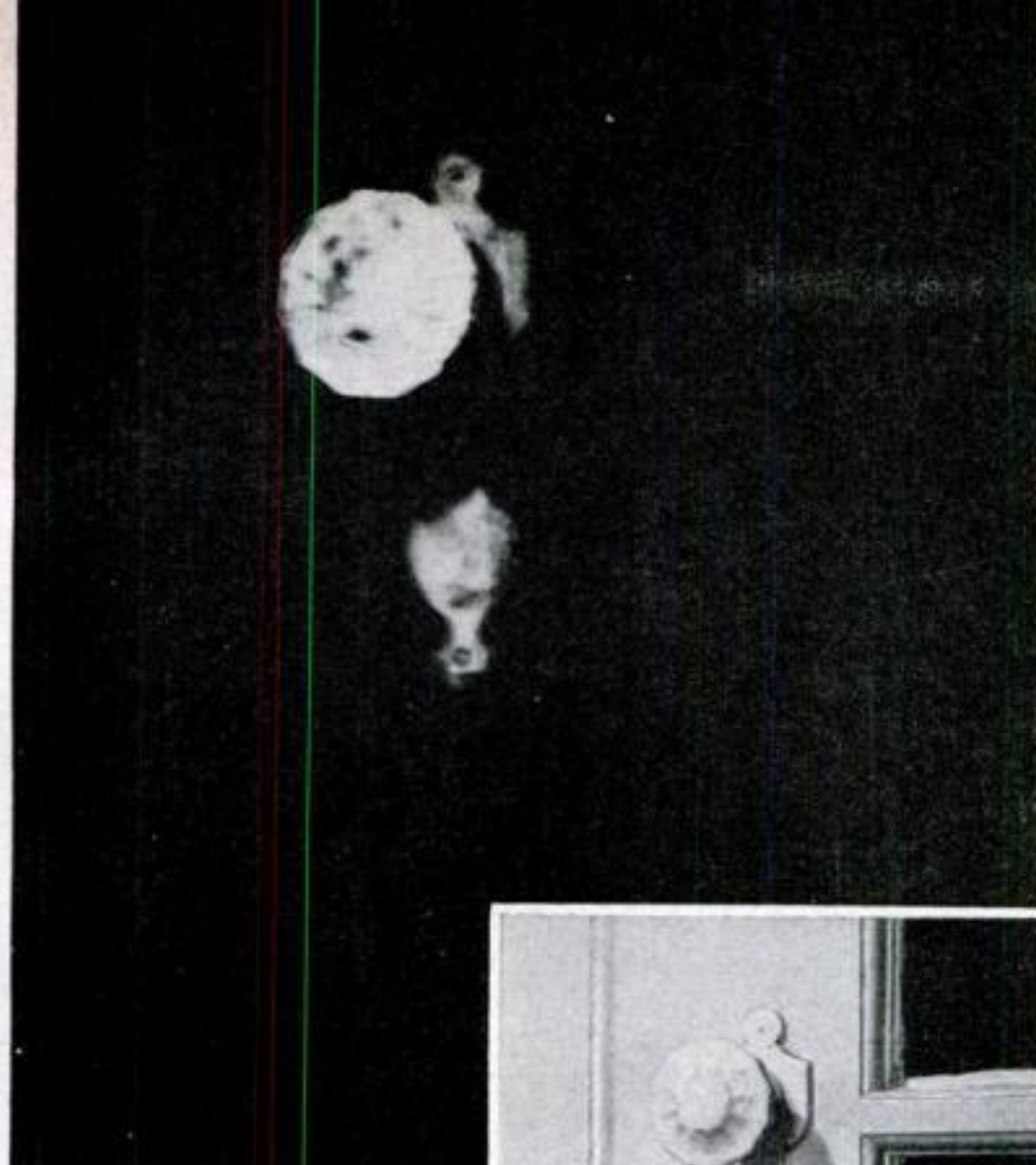
By flying a kite above New York rooftops, and then plucking off adhering metallic particles with a magnet, a chemist found enough of them in city air to have an adverse chemical effect on sensitive luminous paints. Certain ingredients of ordinary paints also prove harmful. Therefore the luminous agent of the new preparation is combined with a special medium of liquid plastic and is put up only in glass bottles.



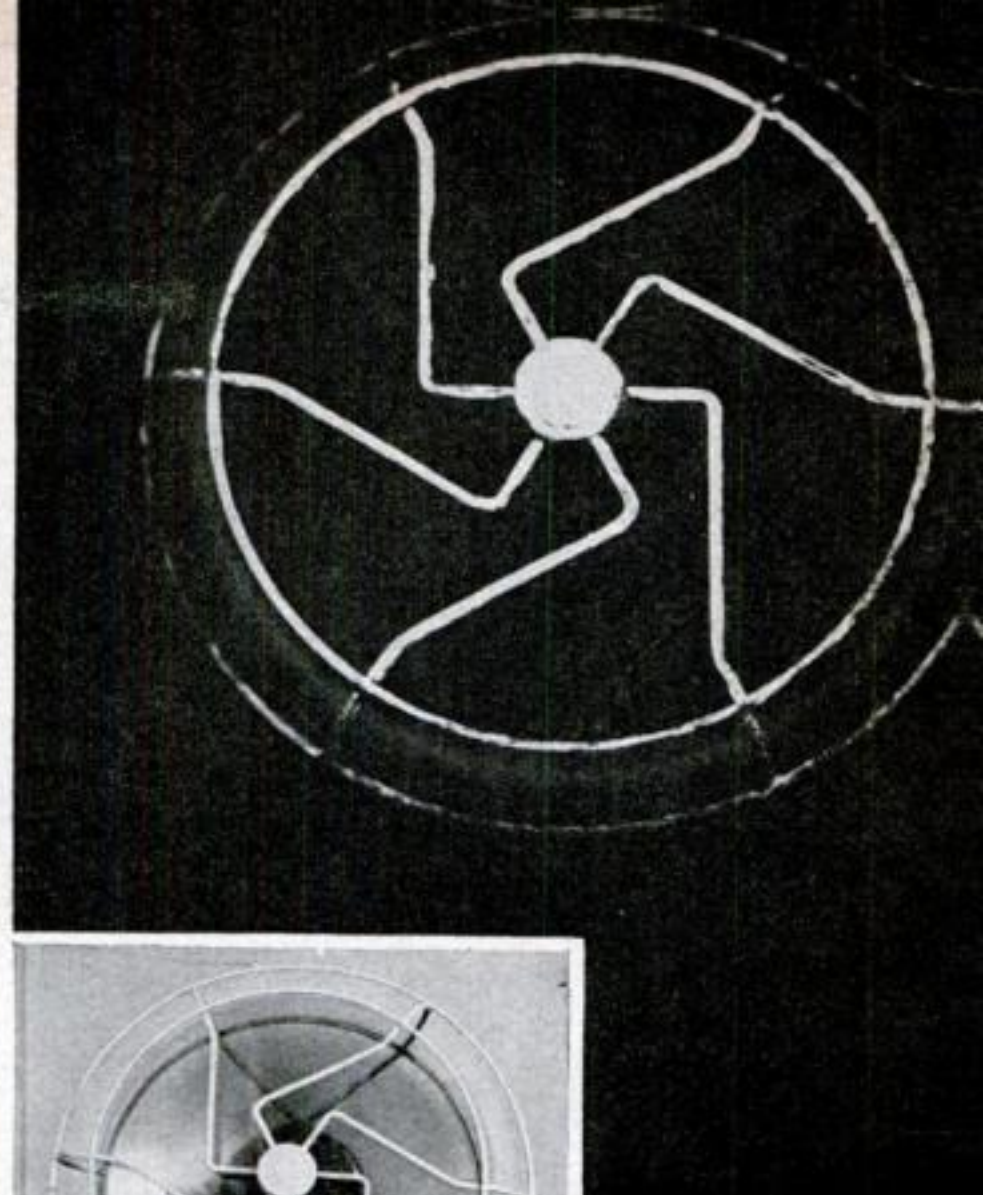
Applying the new luminous paint to edges of stair treads. A special white priming coat goes on first, as above, to prevent contact of the paint with varnish. Then comes the luminous paint itself (below)

The final touch—a clear, transparent finish especially compounded to guard the luminous agent from deterioration caused by dust, dirt, and airborne substances. It also makes the paint washable





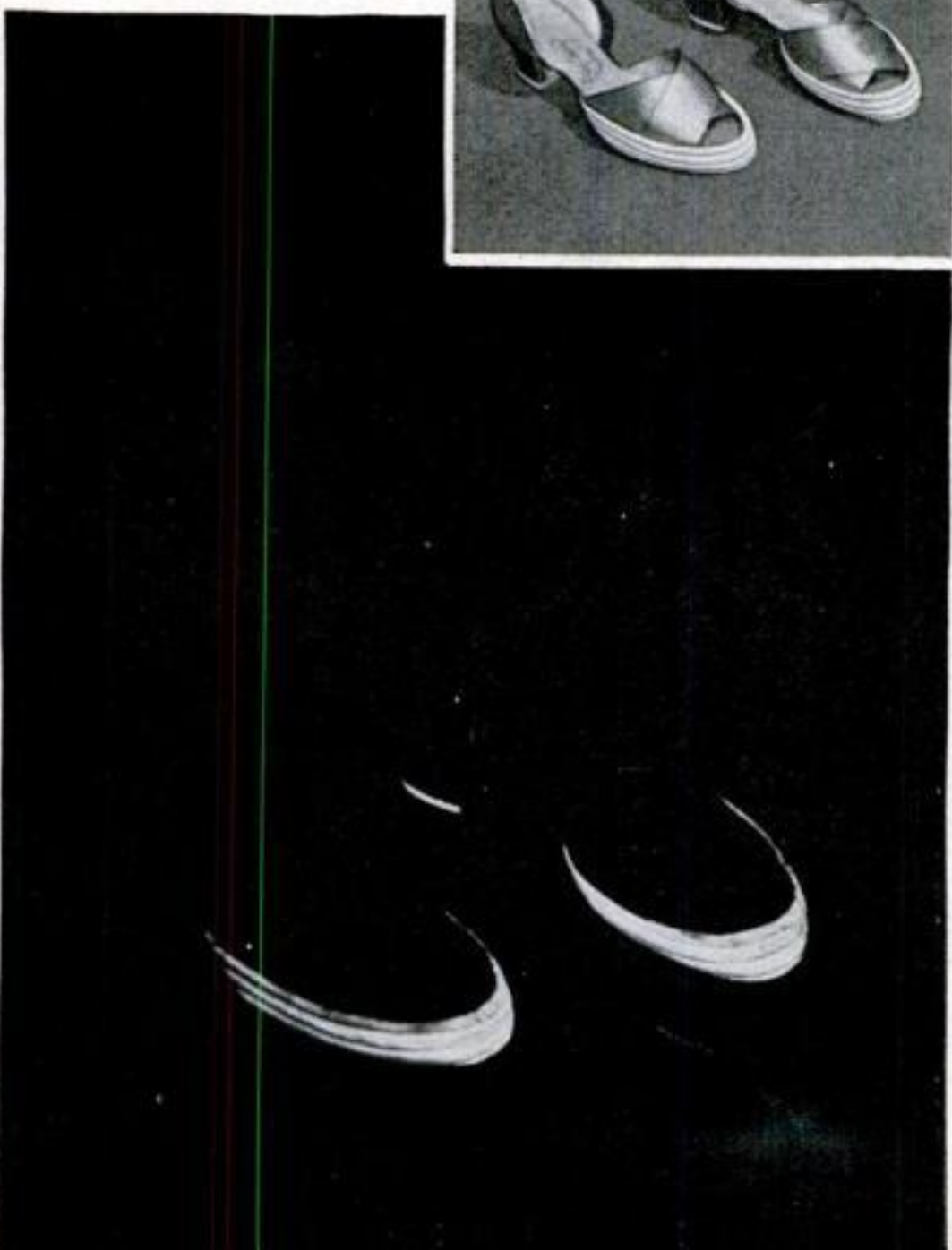
This doorknob is easily found in the dark. By daylight, paint gives it an attractive color



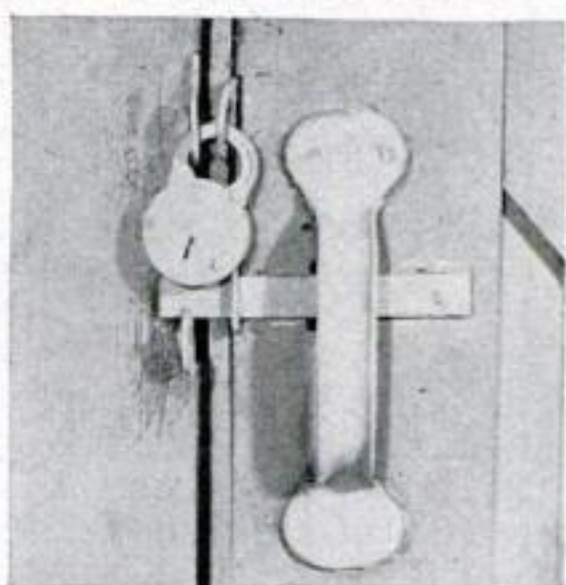
With lights out, this luminous fan guard gives warning of danger lurking in whirling blades



No groping for slippers trimmed with light. The paint does not alter their daytime looks



Fumbling at the garage door is ended when padlock and latch are coated with luminous paint



"Taxi" for Bombs Aids Police in Fight on Sabotage

A "HURRY-UP WAGON" especially designed for bombs has been devised by the police department of Bridgeport, Conn., which has a large concentration of defense industries and is taking special precautions to prevent damage by sabotage. The device, also known as a "bomb taxi," is a cylindrical tank, reinforced by heavy cable and mounted on a two-wheeled trailer. When an object suspected of explosive capacities is discovered, a police emergency truck dashes to the scene with the "bomb taxi" bouncing behind it. The object is dumped into the tank, where it is made harmless by an oil bath, and is trundled off without further danger.



Rescue Belt Helps Firemen to Carry Victims on Backs Like Knapsacks

A RESCUE BELT that makes it easier to carry fire victims from burning buildings has been made standard equipment for each member of the Monrovia, Calif., fire department. The belt consists of a large loop of heavy web belting equipped with a sliding metal hook. The rescuing fireman places the belt, doubled, around the back of the victim, and by putting his arms through the two loops at the ends he can lift his burden like a knapsack. His hands are free for climbing. The hook is placed so that it rides horizontally on the fireman's shoulder; when he needs a rest, he can slip it over a rung of the ladder to support his load. The belt also helps in carrying hose up the ladders.

This rescue belt with hook for resting the fireman is in use, in the photo on the right, for carrying victim down a ladder. Fireman's hands are left free to grip the rungs in climbing



Cheaper Power for Defense Industries

MAMMOTH EARTH-AND-CONCRETE DAMS WILL HARNESS LAZY SOUTHERN COASTAL RIVERS IN VAST PROJECT

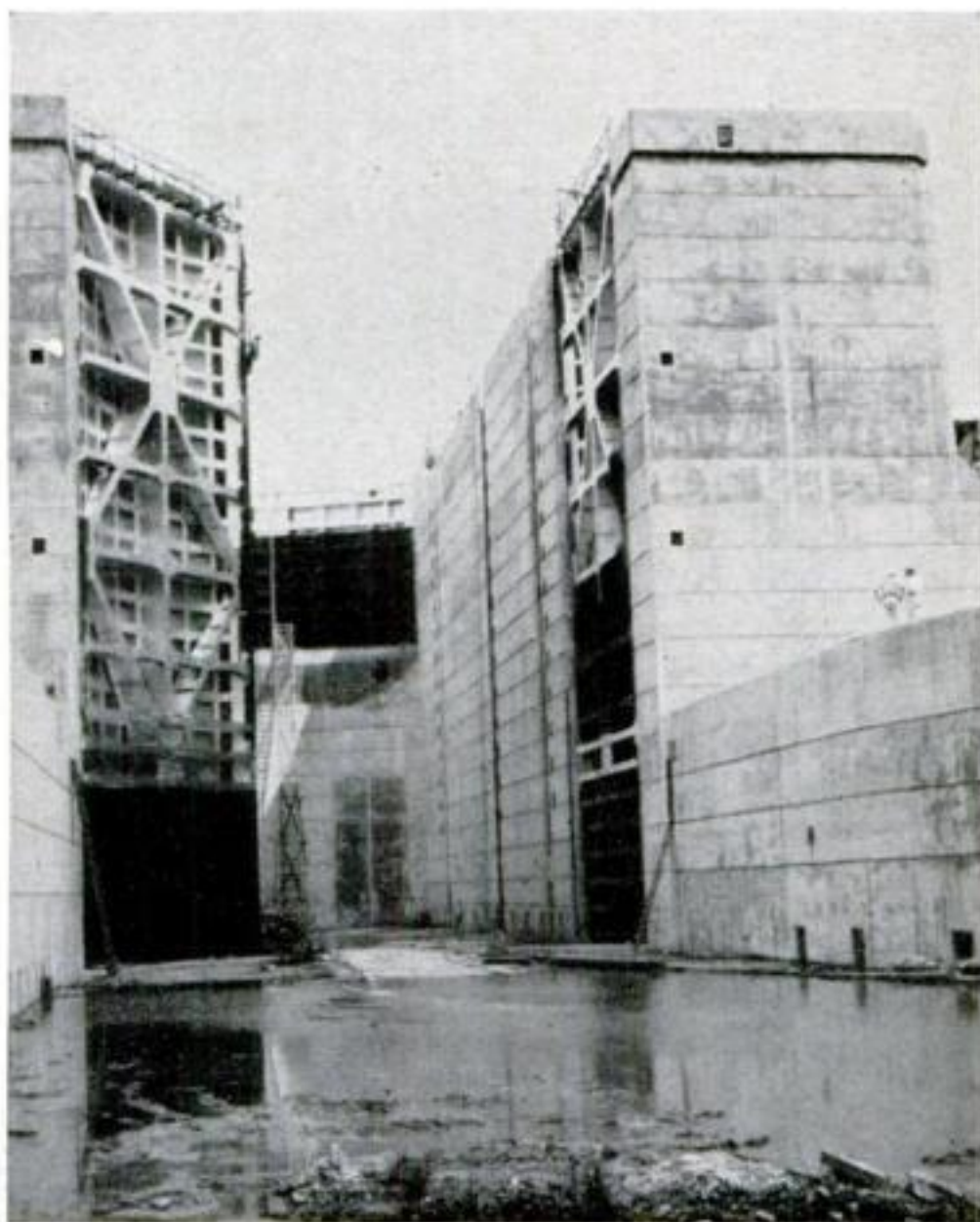
ONE of the most important hydroelectric plants in the Eastern United States is taking shape in the low country of South Carolina, an area commonly believed to be too flat for the development of hydraulic power. Originally designed as a peacetime power and navigation program, this Santee-Cooper project will be finished in time to provide cheap electricity for new defense industries.

A new plant to manufacture high-grade alloy steels in electric furnaces is already under construction in Charleston to utilize the new power source. Other defense industries are also projected for the South Carolina coastal plain, which lack of an adequate power supply has long kept industrially backward.

Two broad, winding coastal valleys have been bottled up with huge earth-and-concrete dams to form the new project. The dams will create two vast reservoirs to provide a head of 75 feet

of water to operate the hydroelectric plant. The reservoirs will be linked by an eight-mile canal and given outlet to the sea through one of the highest lift locks in the world, forming an inland waterway system to serve much of the state.

The main source of water is the Santee River. Winding through a valley which was



The highest lift lock in the world, shown under construction at the right, forms a part of the Santee-Cooper power and navigation project detailed in the map below. It will raise vessels 75 feet to the new Pinopolis Reservoir



once little more than a cypress swamp, the Santee flows into the Atlantic 45 miles north of Charleston. It drains nearly half of South Carolina and, at flood stage, passes 368,000 cubic feet of water a second, one and one-half times the maximum flow of the Hudson River at Troy, N. Y.

Across the lower reaches of this valley at Wilson's Landing, S. C., has been thrown an earthwork dam eight miles long. The central section of the dam is a 3,400-foot concrete spillway equipped with 62 sector gates to control the level of the Santee Reservoir which will be backed up for 35 miles behind

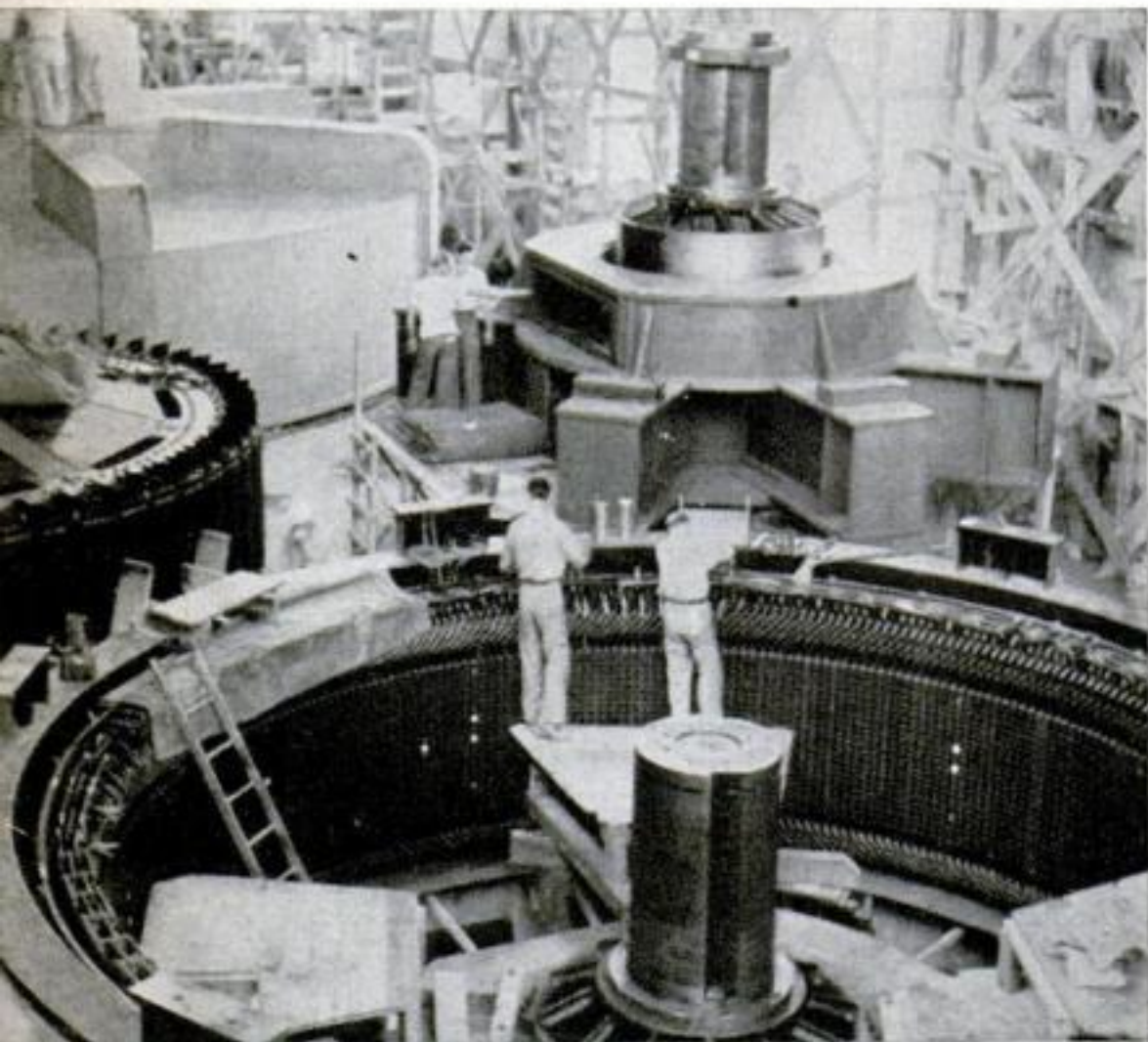
it and will cover an area of 150 square miles.

The Santee River near Wilson's Landing swings to the south. This brings it near to the head of another large valley, formed by Biggin Creek. This drains into Cooper River, a tidal stream flowing into Charleston Harbor.

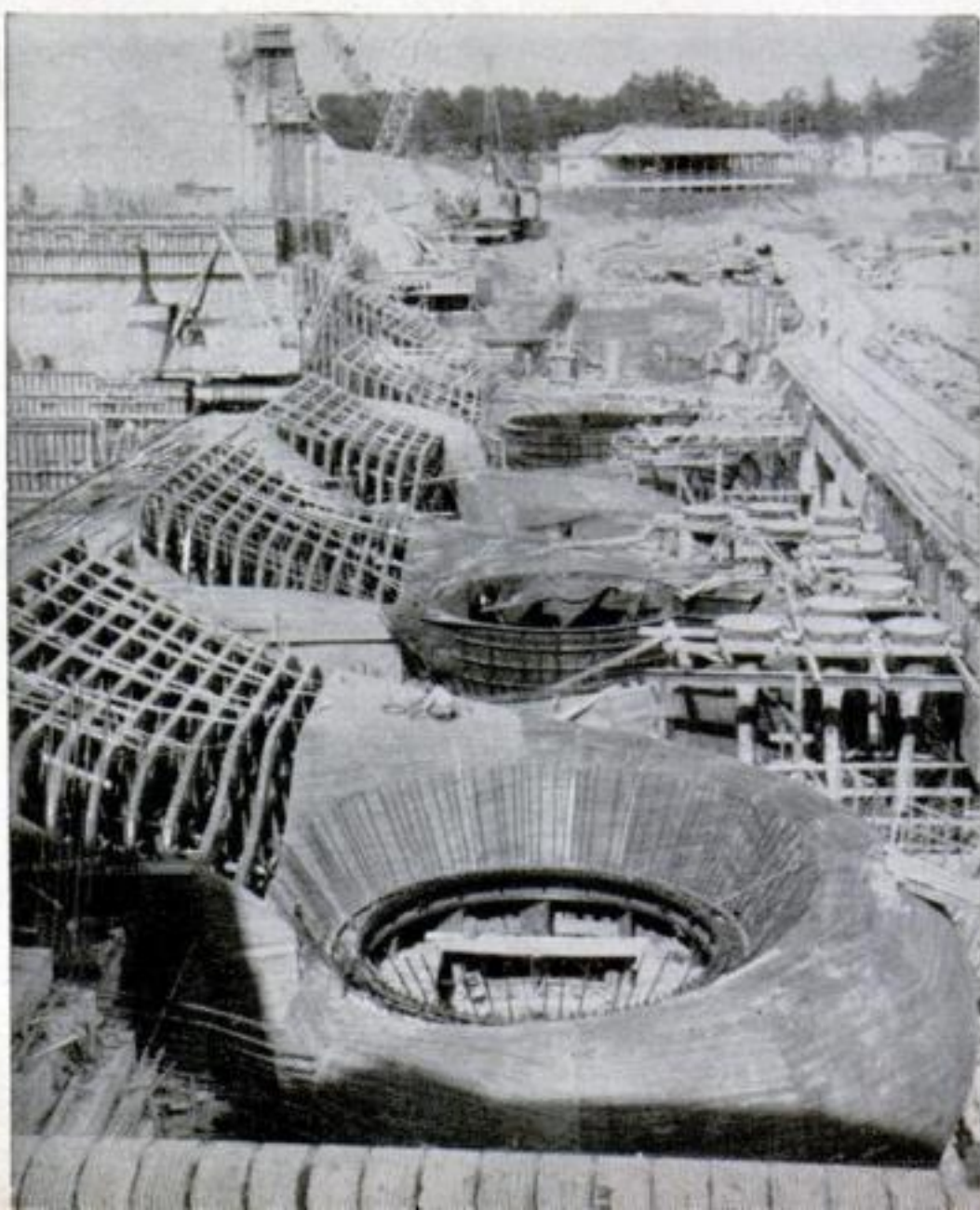
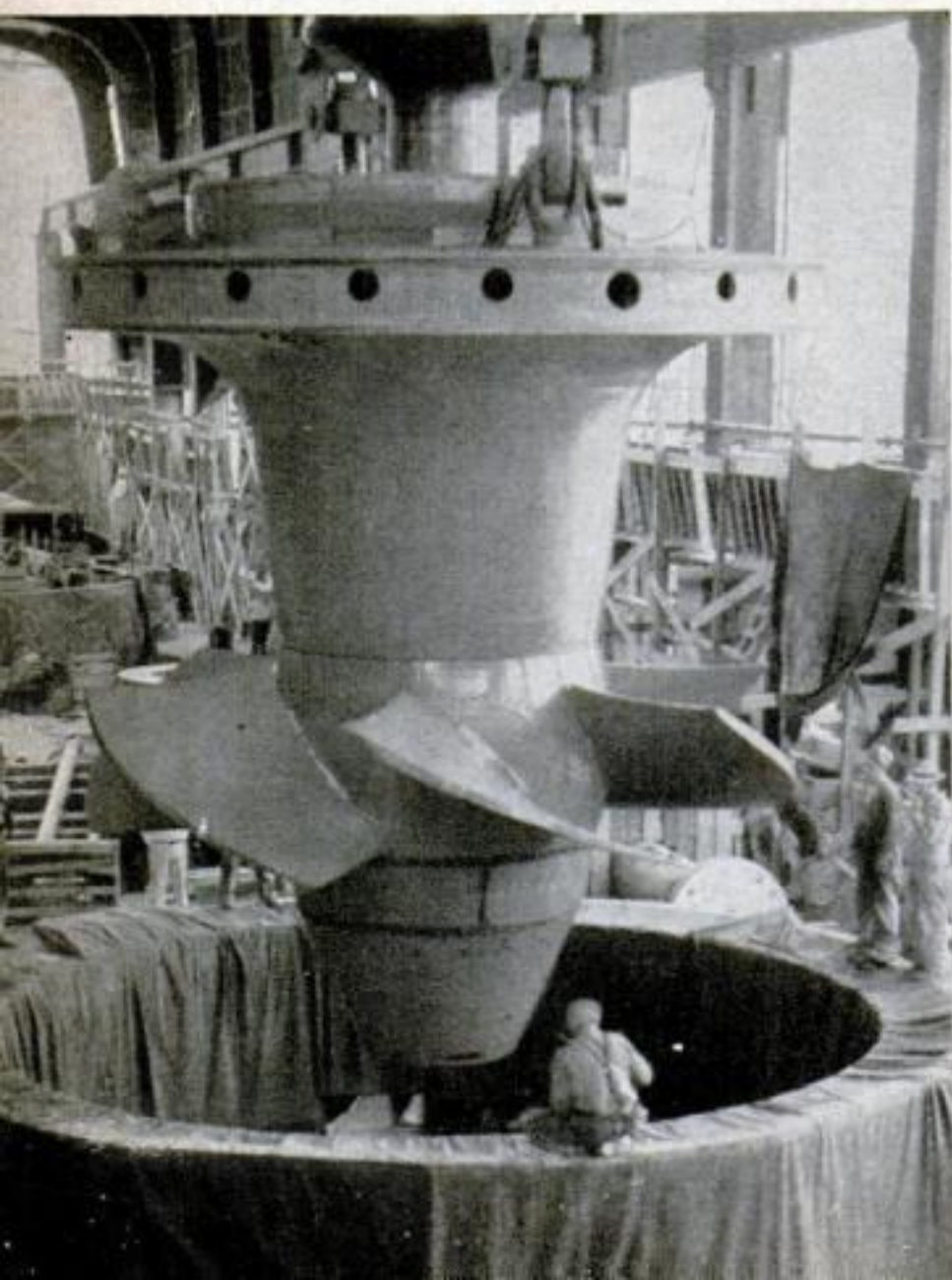
The excavation of 7,000,000 cubic yards of dirt in a cut across the low ridge separating the two valleys made possible the opening of a connecting canal. The Biggin valley was then closed by the construction of earthwork dikes to fill out the ridges and hills which partially surround it and the building of another earth dam across the lower valley just above where it empties into the Cooper River.

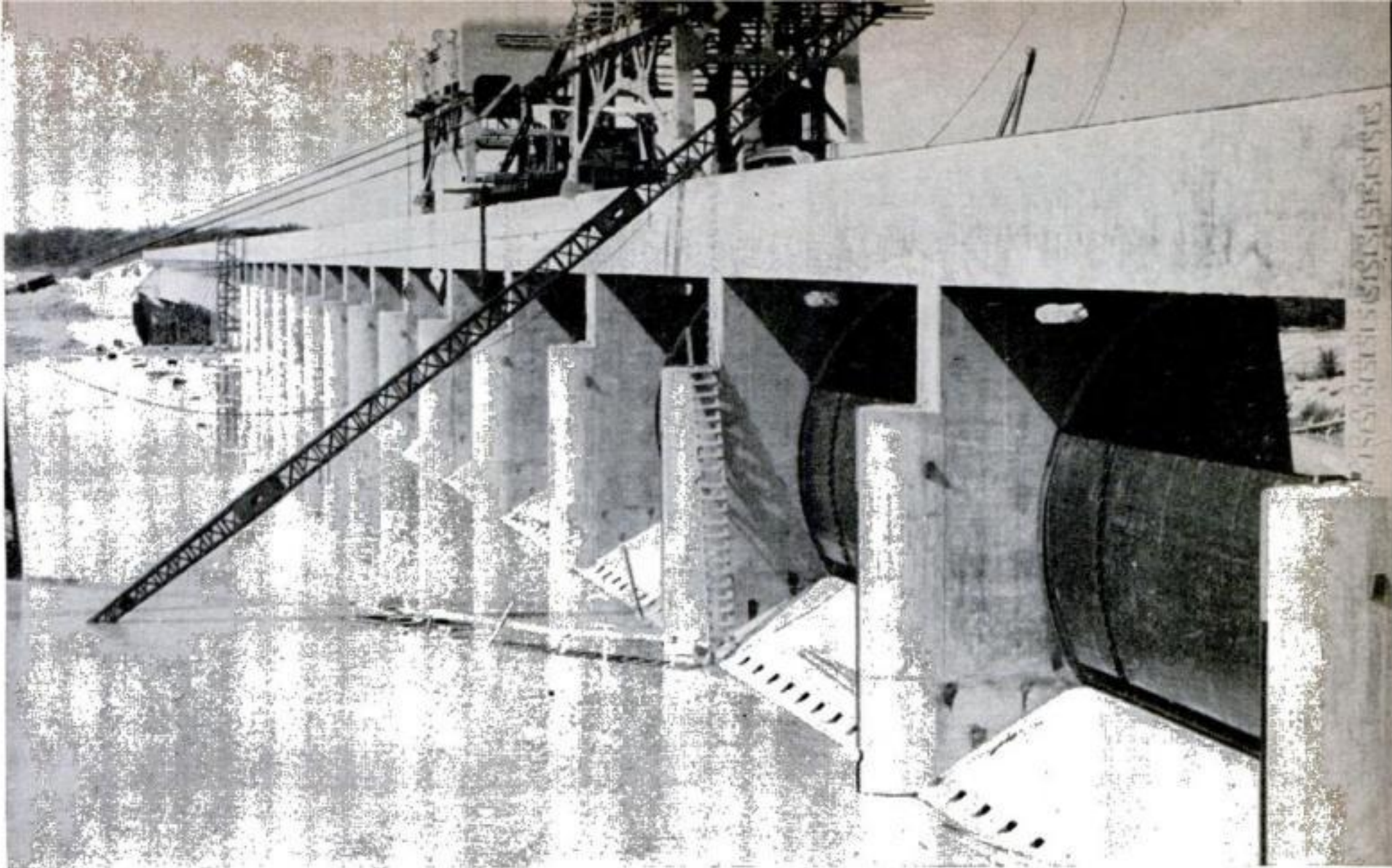
The resulting Pinopolis Reservoir, fed by both Biggin Creek and the overflow of the Santee Reservoir, will have an area of 100 square miles. At the highest point of the earthwork dam a short gravity section of concrete has been built. The hydroelectric plant and the lift lock will be integral parts of this dam section.

The electric plant, built directly in front of the dam, is being



At left, workmen are connecting the windings of the stationary armature of one of the 13,800-volt, 34,000-kilowatt generators. At lower left, an adjustable-blade runner is being lowered into place in a 40,000-horsepower turbine. Below is the bottom section of the power house, showing forms around which the concrete scroll cases for turbines will be poured





This is the upstream side of the concrete spillway which runs for 3,400 feet along the middle of the eight-mile Santee earth dam. Right, form for one of the turbine draft tubes at the Pinopolis plant

equipped with five turbines, four of 40,000 horsepower and one of 13,000 horsepower. The four large turbines will drive 34,000-kw., three-phase, 60-cycle alternators which generate at 13,800 volts. The smaller machine will run a generator of 11,300 kw. capacity. The total capacity of the plant will be 147,000 kw., which may be raised to 181,000 kw. by the addition of a fifth large turbine. Transformers will step up the voltage from 13,800 to 66,000 for delivery to the transmission lines.

The water from the reservoirs will pour through passages in the Pinopolis Dam face and pass through scroll passages to the turbines. From the turbine draft tubes it will discharge into a tail canal at practically the level of tide in the Cooper River. Thus the full head of 75 feet in the reservoirs will fall on the turbines.

The navigation lock, through which barges and small craft will enter the Pinopolis Reservoir from the tail canal, is at the south end of the concrete section. The walls of the lock, which has a chamber 180 by 60 feet, are actually sections of the dam which hold back the full head of water. Steel miter gates close the ends.

The lower Santee River will be closed to navigation by the Santee Dam. By using



the lock lift, however, vessels will be able to cross the Pinopolis Reservoir and pass through the connecting canal to the Santee. They can then proceed to the headwaters of the Congaree and Wateree Rivers, which converge to form the Santee at the head of the reservoir. The project will thus recreate an abandoned canal system built in 1800.

Annapolis Speeds Up

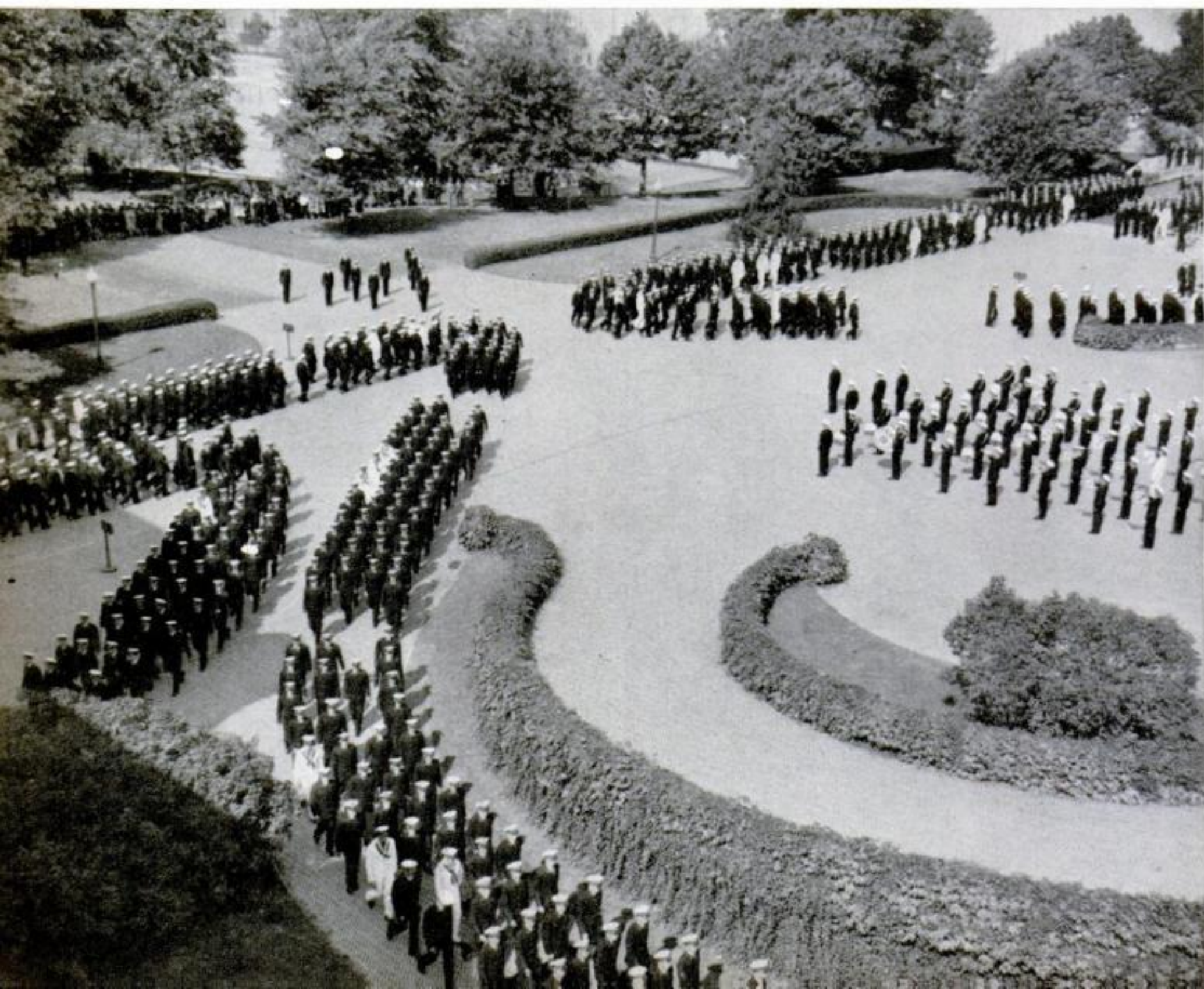
TO TRAIN MORE OFFICERS FOR OUR BIGGER NAVY

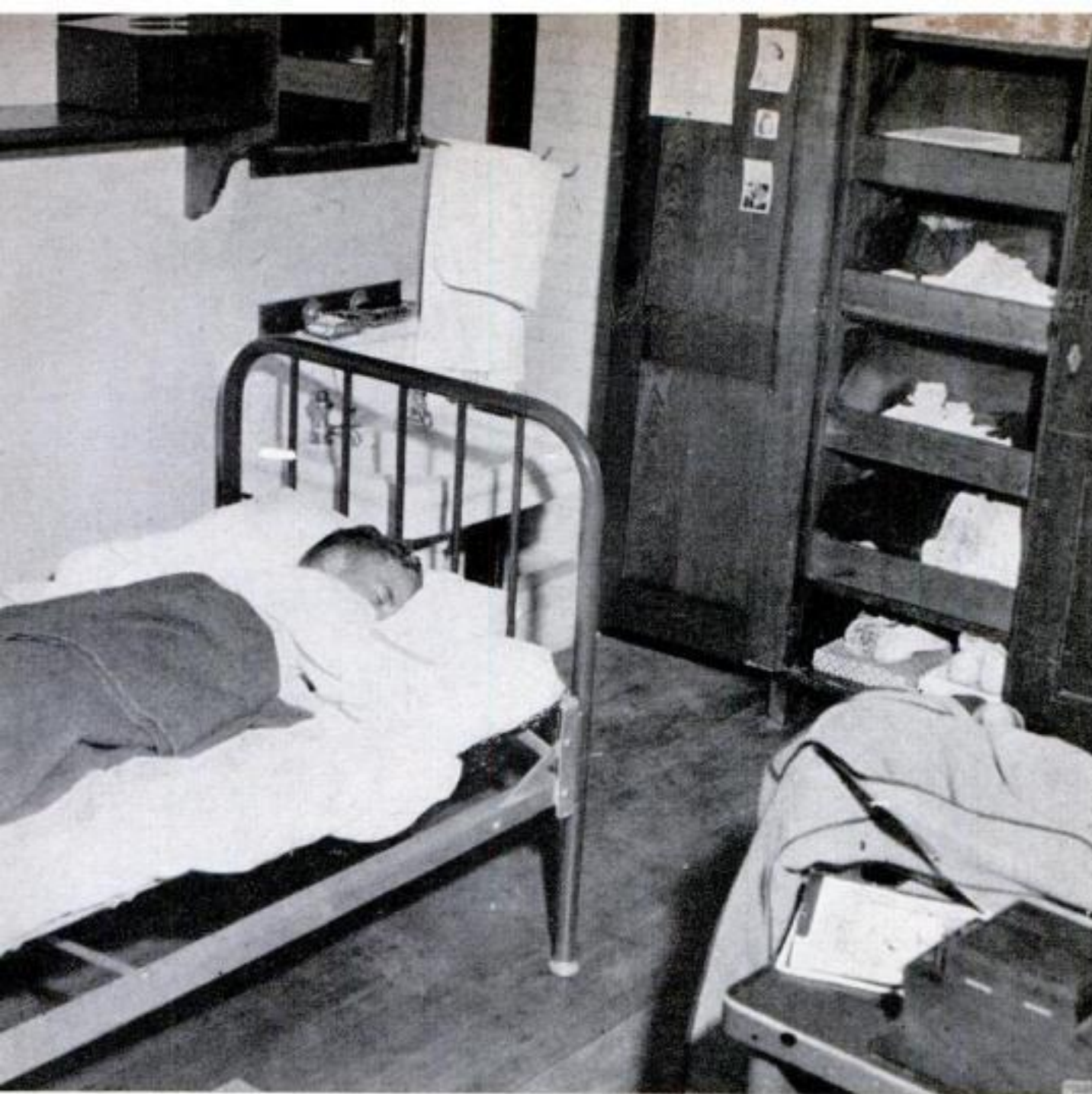
KEEPING pace with the production of new fighting ships in America's naval expansion program, Annapolis has instituted a twofold speed-up in the instruction of officers. Four years' training is being packed into three, and the Academy is accepting a larger number of eligible men than ever before. The 1,156 members of the current class of plebes, or freshmen—the largest in the 96-year history of the institution—have swelled the total number of midshipmen to about 3,100, or 800 above the 2,300 average of recent years. By 1944, of-

ficials expect Annapolis will be turning out between 650 and 700 trained ensigns annually.

In achieving this speed-up, the Academy has neither lowered the physical and mental requirements for entrance nor has it increased the length of the daily schedule. It is being accomplished by curtailing vacation time and by giving cultural subjects a minor role. Under the present program, 51 percent of a midshipman's course is devoted to mathematics and science, 22 percent to professional subjects such as navigation, sea-

Midshipmen marching into Bancroft Hall after noonday formation. Breakfast formation and inspection is held at 6:45 a.m., lunch formation at 12:20 p.m.; and dinner formation at 6:40 p.m. From breakfast formation until drill (3:25 to 4:30 p.m.) midshipmen must wear the blue service uniform with a white cap





Not the cradle of the deep, but a bed in Bancroft Hall, the world's largest dormitory. Most rooms accommodate two men. When bugle and bell sound reveille, each man "hits the deck" and folds blankets and sheets over the head of his bed. A man from each room reports "All out, Sir" to inspectors in the hall

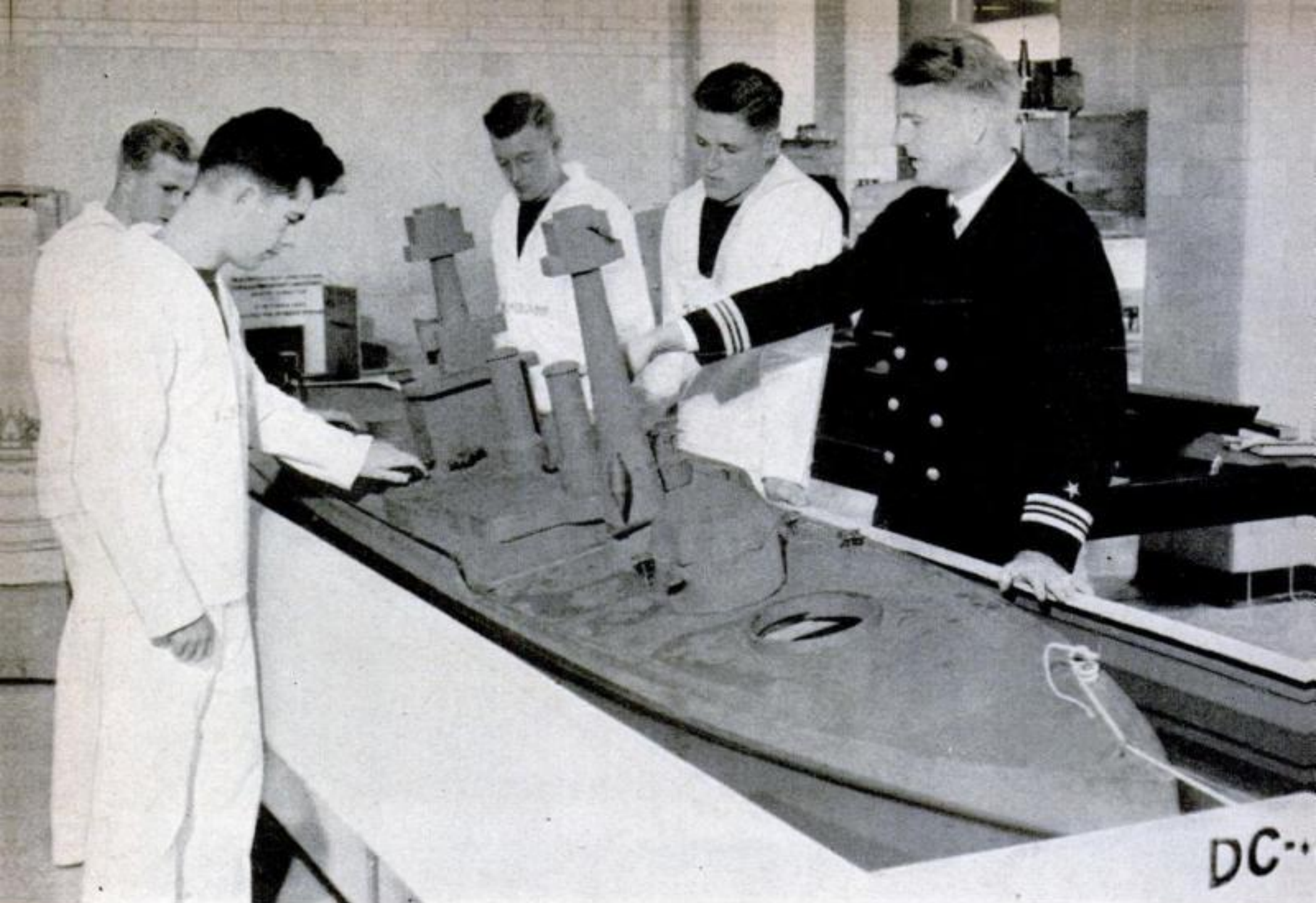
Plebes, or freshmen, returning from classes. They must walk in military manner in the center of the corridor and talk to nobody. Upperclassmen may walk at ease. At the right, a "youngster" (sophomore) is on duty as assistant mate of the deck. There are four recitation periods, the first beginning at 7:45 a.m., the last at 11:05 a.m.



A bottleneck sometimes develops in front of a mirror just before reveille inspection. Twenty minutes are allowed for bathing, shaving, and dressing between reveille (6:20) and breakfast formation (6:45). On Sundays, midshipmen enjoy the luxury of sleeping until 7:15. After breakfast, they make their beds and tidy up their rooms

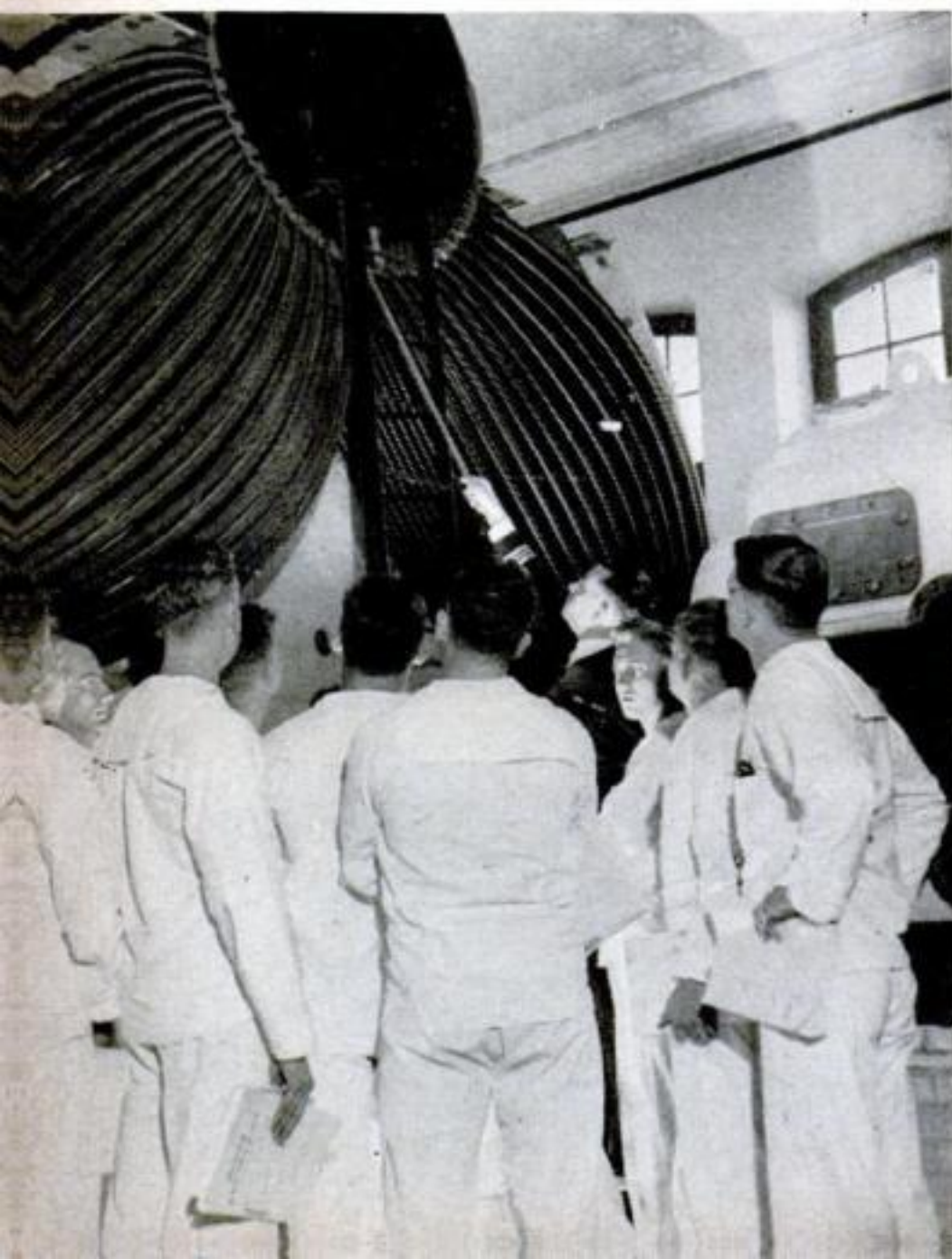
DECEMBER, 1941





"P-work," or practical activities, supplements academic work. Here a lieutenant commander is instructing four first-classmen in the mysteries of "damage flood control." The effect of a shell or torpedo hit is simulated by flooding compartments of a model warship, and students figure out how to keep it in action

Below, an instructor explains the workings of a destroyer boiler that has been set up in the marine engineering laboratory at the Academy

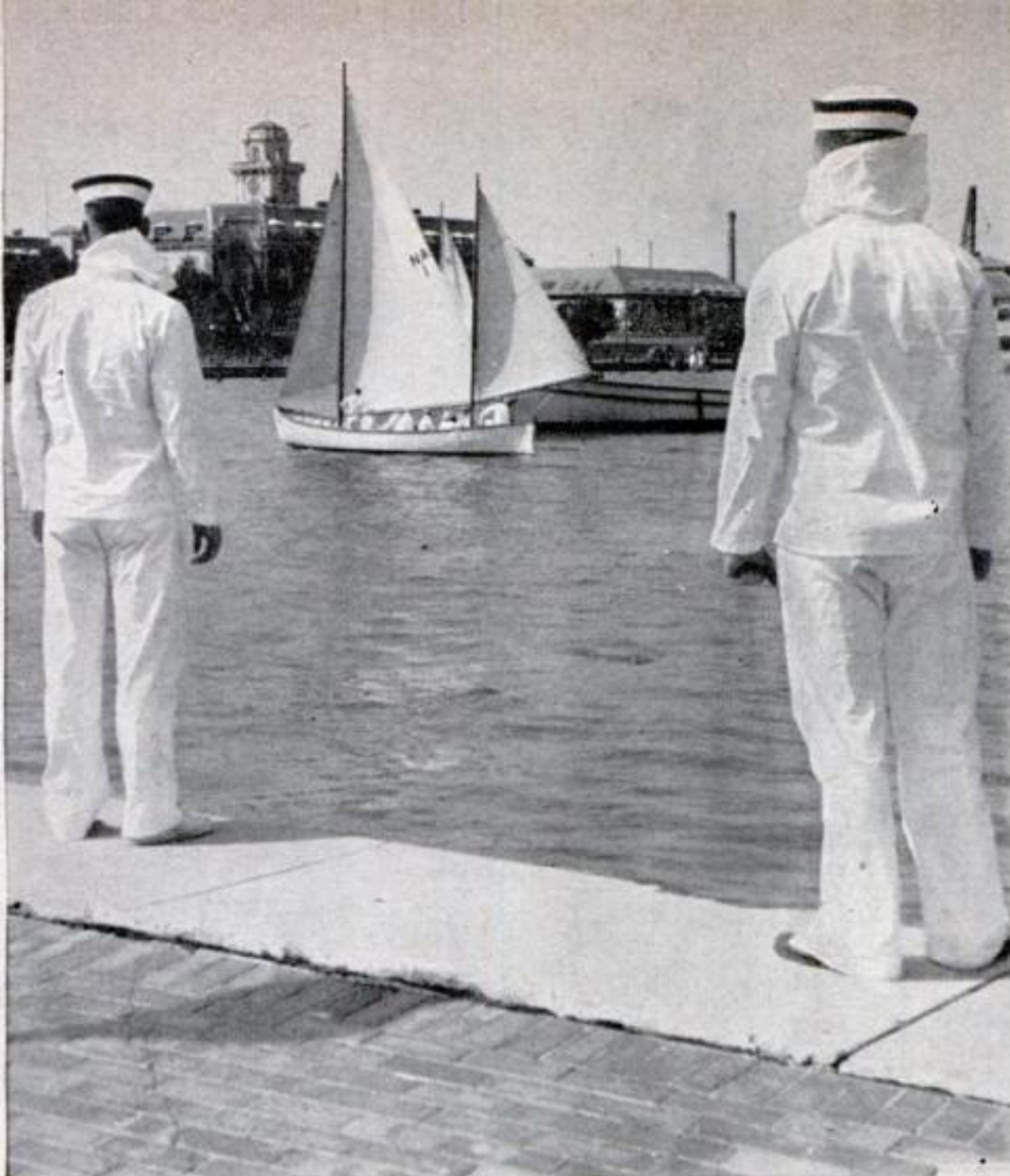


manship, gunnery, and ordnance, and 21 percent to cultural subjects.

The first result of the speed-up was the graduation of the Class of 1941 in December 1940 instead of June 1941. The Class of 1942 will be graduated in December 1941 and the Class of 1943 in June 1942. Thereafter, classes which have completed the four-year course in three years will be graduated each June.

To accommodate the greatly increased number of midshipmen, additional facilities, costing more than \$5,000,000, are being provided at the Academy. Bancroft Hall, where all midshipmen live and eat, is receiving two \$1,000,000 wings which will furnish 326 additional rooms. Other improvements include a new recitation building, additions to the power plant, a seaplane hangar, expansion of the Naval Hospital to provide 100 more beds, additional office space in the administration building and barracks for enlisted men on duty at the Academy.

Ordinarily, the four Naval Academy classes are known as plebe (freshman), youngster (sophomore), second class (junior), and first class (senior). Under the three-year plan, the second-class designa-



Naturally, our future admirals learn to be at home on the water. They practice at rowing and sailing boats in their drill period, and at the end of their first year they go on a practice cruise

tion probably will be discontinued. Plebes wear no sleeve stripes; youngsters wear one diagonal stripe; second-classmen two diagonal stripes; and first-classmen one narrow stripe around the sleeves. Last year, there were three companies in each of the four battalions of the Regiment of Midshipmen. This year, a battalion has five companies.

As in the past, most of the midshipmen are appointed by Congressmen, with about 25 a year receiving appointments from the President. Enlisted men in the Navy and Marine Corps are eligible for 100 appointments, filled by competitive examinations. Another 100 appointments a year are open to enlisted men of the Naval Reserve. Forty percent of all plebes entering the Academy are dropped, or "bilged," before graduation. Those who finish receive a B.S. degree and, usually, a commission as ensign.

In addition to its training of regular midshipmen, the Naval Academy this year gave a three-months' concentrated course for Naval Reserve midshipmen seeking line commissions in the V-7 class of the Reserve. Another three-months' course for 700 men will start in January, 1942. Candidates must have a college education and engineering graduates are especially desired. Similar concentrated courses at other institutions throughout the country are expected to raise the number of Reserve ensigns produced in this way to 5,000 a year. Another source of officer material is the Navy R. O. T. C. in 27 American universities. It is counted on to turn out an additional 1,350 Reserve ensigns a year when the program hits its stride.

DECEMBER, 1941



Physical well-being is not overlooked, an afternoon period of two hours or more each day being devoted to athletics or other body-building activity. Here the gymnasium coach, C. W. Phillips, takes a reading as a lad tests his forearm flexors on a machine



Dinner comes at 6:40 p.m. Note the "plebe position" held by the middy at lower right: shoulders held stiffly upright, four buttons of the blouse showing above the table. Hash is "deep see mystery"; pancakes, "collision mats"

After a relaxation period, about half an hour following dinner, comes study call. Tattoo sounds at 10; taps (lights out) at 10:05



Here's



1 TODAY, DR. C. GUY SUITS IS ONE OF AMERICA'S LEADING RESEARCH SCIENTISTS. HE IS THE MAN WHO PRODUCED THE WORLD'S HOTTEST FLAME. TWENTY-ODD YEARS AGO, HE STARTED HIS FIRST JOB. IT WAS JERKING SODAS IN HIS FATHER'S DRUG STORE IN MEDFORD, WIS.



2 TO HELP PAY EXPENSES AT THE UNIVERSITY OF WISCONSIN, SUITS GAVE CLARINET LESSONS TO AS MANY AS 35 STUDENTS A WEEK. HE GRADUATED IN 1927, MAJORING IN PHYSICS AND MATHEMATICS



3 THE FOLLOWING YEAR, WHILE WORKING AT THE U.S. FOREST PRODUCTS LABORATORY, MADISON, WIS., HE INVENTED AN ELECTRICAL DEVICE FOR MEASURING THE MOISTURE CONTENT OF STORED WOOD



4 ON A SCHOLARSHIP TO THE INSTITUTE OF TECHNOLOGY, IN ZURICH, SUITS STUDIED IN SWITZERLAND IN 1929. TAKING UP SKIING, HE INVENTED A NEW METHOD OF REINFORCING THE EDGES OF SKIS

My Story

THE CAREER OF DR. C. GUY SUITS



5

AFTER HIS RETURN, HE JOINED THE RESEARCH STAFF OF THE GENERAL ELECTRIC COMPANY, SPECIALIZING IN THE STUDY OF ELECTRIC ARCS



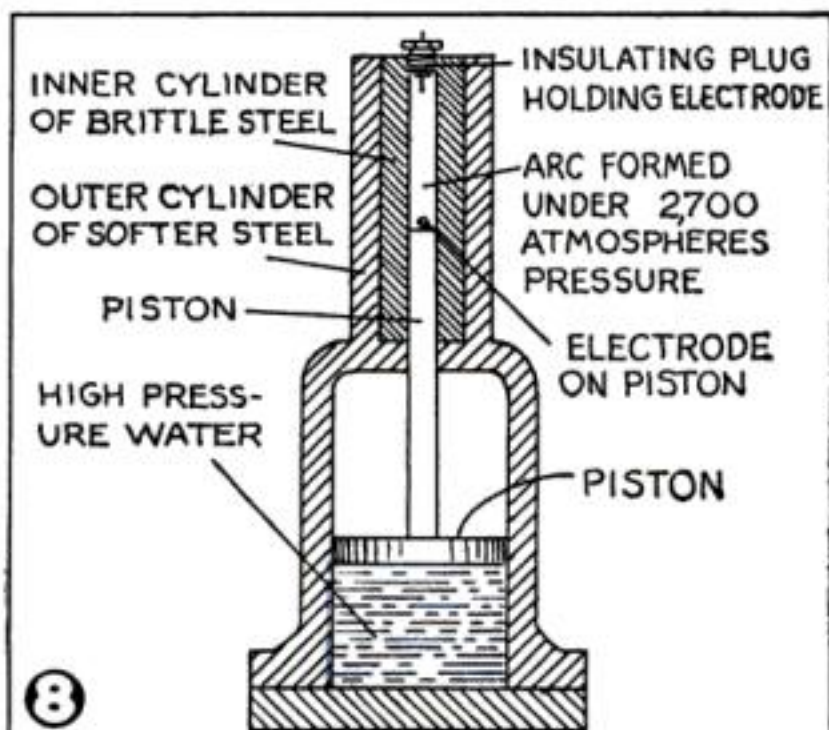
6

SUITS DEVELOPED A METHOD OF MEASURING THE HIGH TEMPERATURES OF ARCS BY PHOTOGRAPHING SOUND WAVES PASSING THROUGH LUMINESCENT GASES



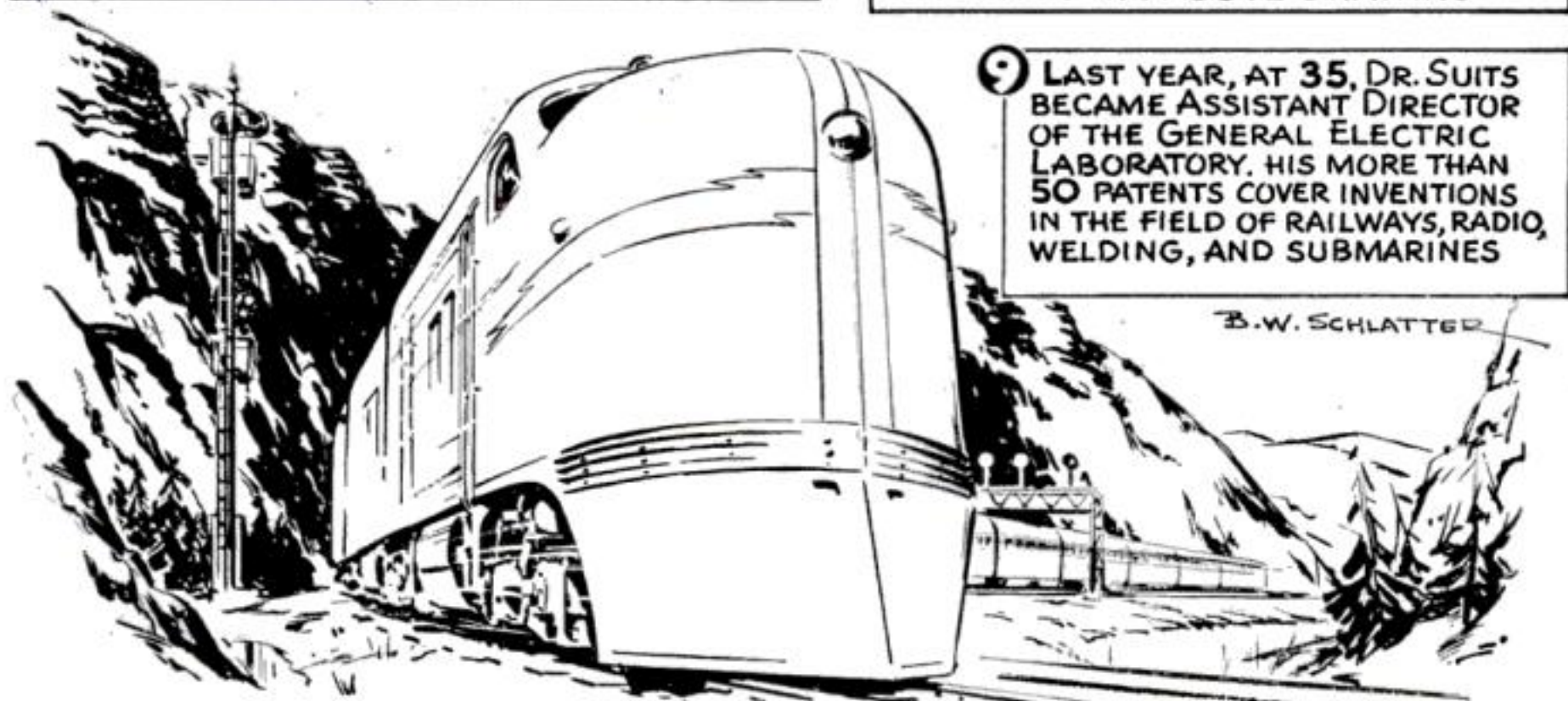
7

EIGHTEEN THOUSAND DEGREES F.—MORE THAN TWICE THE TEMPERATURE OF THE SURFACE OF THE SUN—WAS ATTAINED BY SUITS WHILE EXPERIMENTING WITH AN ARC UNDER 2,700 ATMOSPHERES PRESSURE



8

DETAILS OF THE DOUBLE-WALLED STEEL CYLINDER USED BY SUITS IN HIS HIGH-TEMPERATURE ARC EXPERIMENTS ARE SHOWN IN THE ABOVE DRAWING



9

LAST YEAR, AT 35, DR. SUITS BECAME ASSISTANT DIRECTOR OF THE GENERAL ELECTRIC LABORATORY. HIS MORE THAN 50 PATENTS COVER INVENTIONS IN THE FIELD OF RAILWAYS, RADIO, WELDING, AND SUBMARINES

B.W. SCHLATTER



Socks worn over the shoes deaden scuffling sounds in dancing scenes and walking scenes. Here Bernard Brown, sound chief at Universal, fits them on Maria Montez



Even the big sets are sound-deadened by installing walls made of canvas, which are painted realistically with water colors

Manufacturing Quiet for the Movies



Giving a skirt an audition. Dresses are all tested for sound; in close-ups, silk is replaced by celanese taffeta. Old Man Microphone catches everything, and his sensitive ear seems specially attuned to a real silken rustle. Thus, the silkworm's product is banned in any close-up in which silence is golden

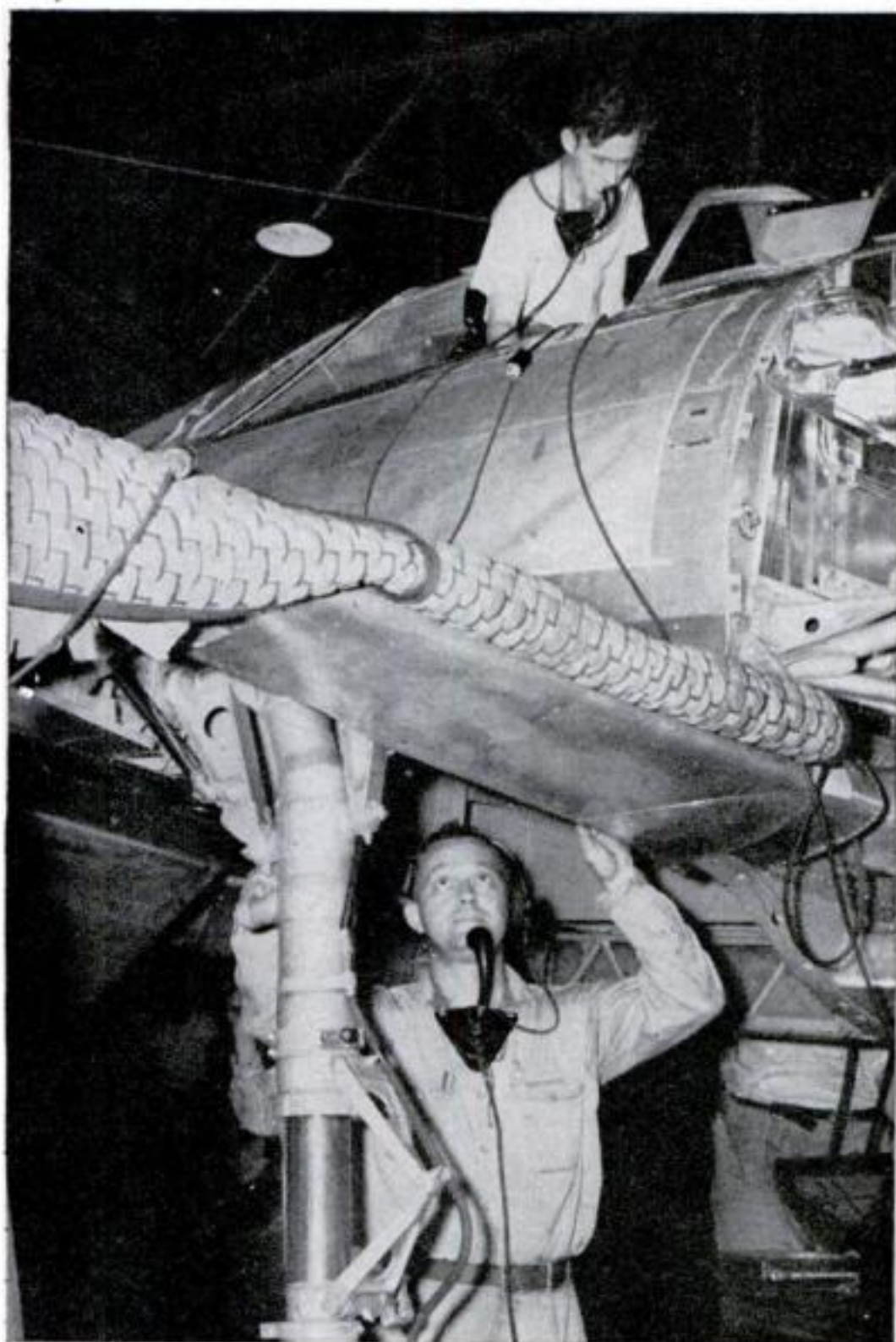
SILK is not silk on a Hollywood sound stage, gravel is not gravel, cement is not cement, grass is not grass, carpets are not wool, walls are not wood, and a singer doesn't sing. These are among the deceptions developed by the industry to kill stray noises. A tour of Universal Studio by a Popular Science cameraman disclosed the latest tricks of the sound experts. Silk gives off a disturbing rustle, so actresses wear celanese taffeta, and even then their dresses are sound-tested. In dancing and indoor scenes where dialogue must be heard clearly, socks are worn over shoes. Gravel walks are made of chipped and dyed cork to kill the crunch of actors' feet. Cement walks are simulated by soft building board, and artificial fiber grass replaces real grass. Burlap walls are substituted for wood to eliminate reverberation. Grass pads absorb the drip of fake rain. A singer records his or her voice in a soundproof booth, the music being dubbed into the picture later by synchronization. Before the camera the scene is shot silent, as in the old days.

Cement isn't cement, and grass isn't grass. These workmen are laying soft building board in squares to represent a concrete walk, and placing artificial fiber grass to simulate a grassy lawn border



POPULAR SCIENCE

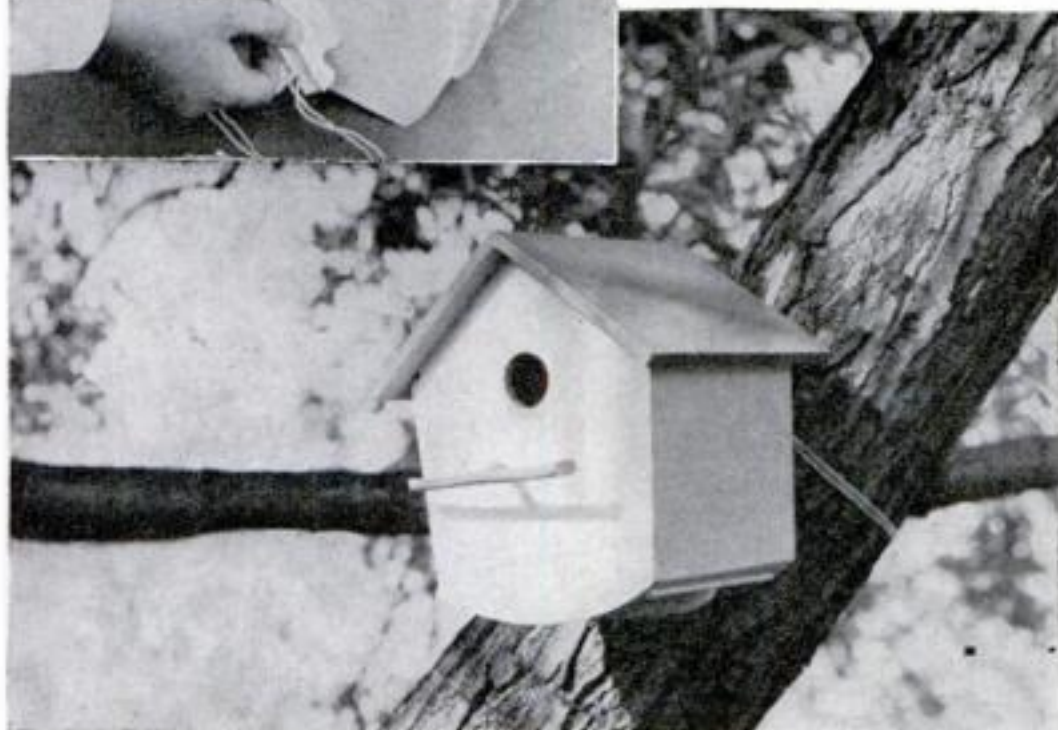
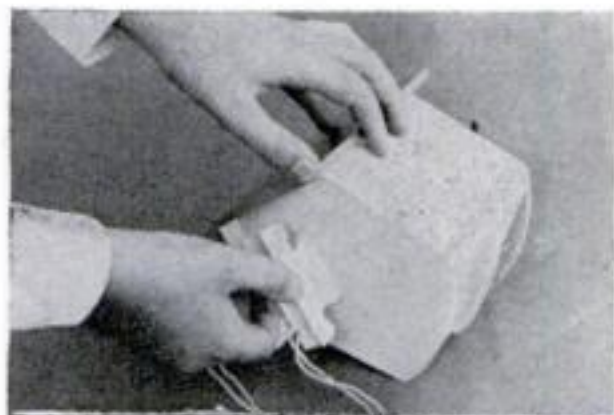
Portable Phones Save Time for Aircraft Workers



TELEPHONES are being used to speed airplane production, but not in the way you would suspect. In the Republic Aviation Corporation's plant at Farmingdale, N.Y., assembly-line workers use them for communication between men inside fuselages and those outside. Before the telephones were put into use, it often took several minutes for instructions to be transmitted to men working inside the planes. The noise of the factory and the metal shell surrounding them made it impossible for the inside workers to hear even shouted orders, and another workman had to crawl inside the plane to carry the message.

Now, however, such messages are transmitted in a matter of seconds. Inside and outside workers wear telephones like those used by switchboard operators—lightweight headphones held in place with a spring clamp and transmitters strapped to their chests. This type of equipment leaves their hands free to continue work even when they are engaged in conversation. Almost any number of phones may be hooked into a single circuit. No figures are available yet on time saved by the use of phones, but it has been estimated that in a month it will amount to enough to build a complete plane.

Bracket Adjusted to Angle of Limb Keeps This Bird House Upright



TO MAKE the bird house shown at the left easy to mount in an upright position regardless of the angle of the branch to which it is to be fastened, it is fitted with an adjustable bracket which can be twisted to any desired position. The house, which is built for wrens and has an entrance too small to allow sparrows to enter, is designed to be fastened in place with cord, thus eliminating the need for tools when putting it up. By tarring or varnishing the cord to protect it from the weather, this type of fastening can be made to last a long time.

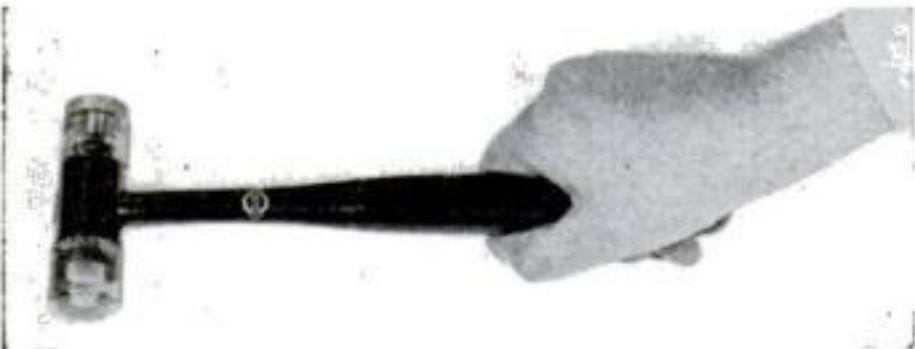
DO YOU KNOW YOUR HAMMERS?

IF YOU call any one of the ten tools pictured below a hammer, you are absolutely right. But what kind of a hammer? For there are almost as many kinds as there are trades and crafts.

Illustrated are an upholsterer's hammer,

nail hammer, engineer's hammer, jeweler's (or hobbyist's) hammer, machinist's hammer, riveting hammer, machinist's soft-face hammer, body worker's (metalworker's) hammer, chisel-edge claw hammer, and boiler inspector's hammer.

Try to write the correct name under each, and check your results with the list below—printed upside down to remove temptation.



1



2



3

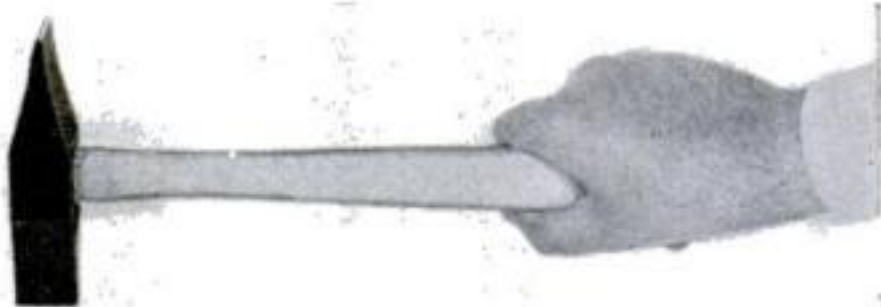


4



5

ANSWERS
1. Machinist's soft-face. 2. Machinist's. 3. Engineer's. 4. Riveting. 5. Nail. 6. Boiler inspector's. 7. Upholsterer's. 8. Body worker's. 9. Jeweler's. 10. Chisel-edge claw.



6



7



8



9



10

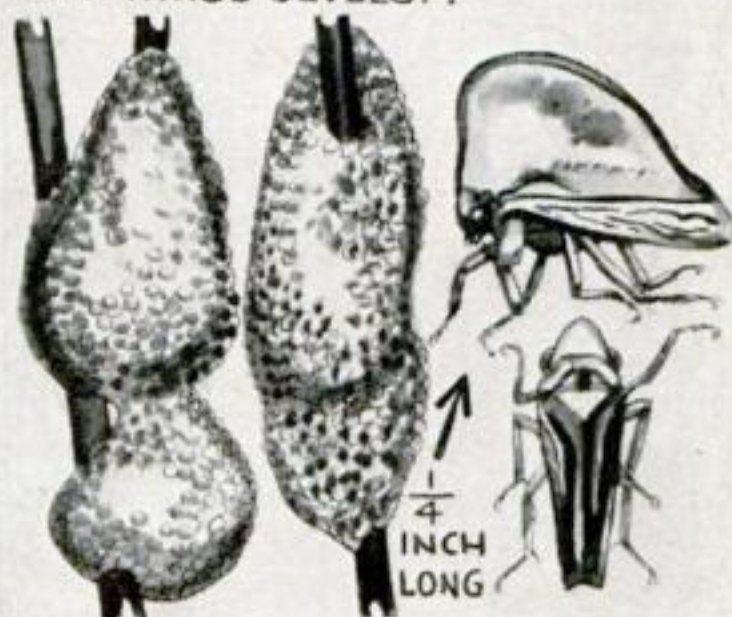
Un-Natural History

BY
Gus Mager



FROGS MAY LOOK ALIKE TO YOU, BUT THEY DON'T TO OTHER FROGS. **SOUTHERN LEOPARD FROGS** ARE SO SNOOTY THAT THEY REFUSE TO MATE WITH ORDINARY LEOPARD FROGS EVEN THOUGH THEY LIVE IN THE SAME POOL!

THOSE BUNDLES OF BUBBLES THAT CLING TO WEED STEMS ARE NOT CUCKOO SPIT, AS THEY ARE OFTEN CALLED. THEY ARE MADE BY **FROGHOPPERS**, OR SPITTLE INSECTS, AS NESTS IN WHICH TO LIVE UNTIL THEIR WINGS DEVELOP!

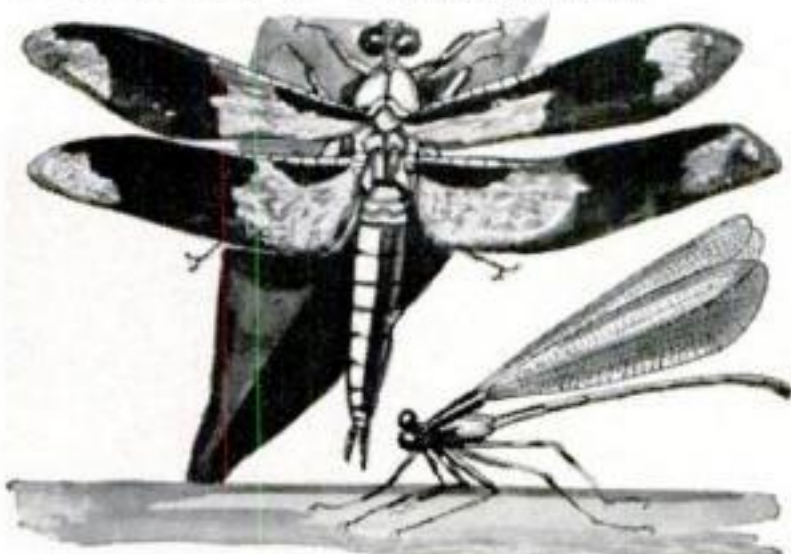


NIGHTHAWKS ARE NOT HAWKS AT ALL, BUT **GOATSUCKERS**. TO MAKE IT MORE COMPLICATED, THEY DO NOT MILK GOATS, THOUGH LEGEND SAYS THEY DO! THEY OFTEN FLY NEAR THESE ANIMALS IN SEARCH OF INSECTS ON WHICH THEY FEED



MILK SNAKES ARE THE SUBJECT OF ANOTHER FALLACIOUS LEGEND ABOUT MILK. THEY FREQUENT STABLES AND DAIRIES IN SEARCH OF MICE AND RATS, BUT DO NOT DRINK MILK. THEY DON'T EVEN DRINK MUCH WATER!

MOST DRAGON FLIES REST WITH THEIR WINGS SPREAD OUT FLAT. BUT **DAMSEL FLIES**, ONE OF THE SAME SPECIES, FOLD THEIR WINGS OVER THEIR BACKS, JUST TO BE DIFFERENT!



IF YOU THINK FISH AREN'T TOUGH, TACKLE A **GAR FISH** SOMETIME. BIG ONES, SOMETIMES WEIGHING SEVERAL HUNDRED POUNDS, HAVE SCALES SO HARD THAT THEY CAN'T BE PIERCED WITH AN AXE!

Can America Build

**WE NEED 4,000 OF THEM
TO TAKE CARE OF OUR
EXPANDING AIR FORCES**

By P. O'MALLEY

HOW many airports is enough? America needs between 3,500 and 4,000, according to the Civil Aeronautics Administration, which has planned the nation's airport-construction program. This program was presented to Congress in March, 1939, and was based on expansion of civil and commercial aviation anticipated at that time. The war crisis has since forced the emphasis to be removed from civilian flying and concentrated on military aviation. As a result, changes in the design and placing of the airports have been made, but, according to the C.A.A., the total number needed still remains the same.

Can we produce them?

We can, and more if necessary. The need is for coöperation between the Federal and local governments in allotting funds, sites, and materials. Congress appropriated 40 million dollars last fall to get the program under way. Eighty million more was added in July to continue the work. Many more millions will be needed if the program is to be completed as outlined.

Are we producing them?

Yes, and speedily. When the C.A.A. got its first appropriation a year ago, 200 airport projects were started. Nearly \$19,000,000 of the second appropriation is being used to complete 113 of these airports. The rest is going toward a string of 288 new ones around the perimeter of the United States. Military airports are most needed along the Atlantic, Gulf, and Pacific coasts, which must be defended strategically and because of their industrial concentrations.

In New England, for example, including New York, a total of 55 projects costing

\$14,259,670 have been started. In other Atlantic Coast areas an additional \$15,286,000 will be spent. For work along the Gulf of Mexico \$12,950,000 is allotted and along the Pacific Coast, \$8,006,000.

Small, self-contained cities are actually springing up around the country as these C.A.A. projects and the vast flying fields being built by the Army take shape. The larger airports, in addition to actual landing, storage, and repair facilities for aircraft,



Army air fields dot the map as the defense program gets into full swing. Those shown are the most important ones at present, but even as this map was being made ground for more and more fields was being broken. In many cases the Army shares facilities at municipal or commercial fields, and coöperates with local private aviation activities

Enough Airports?

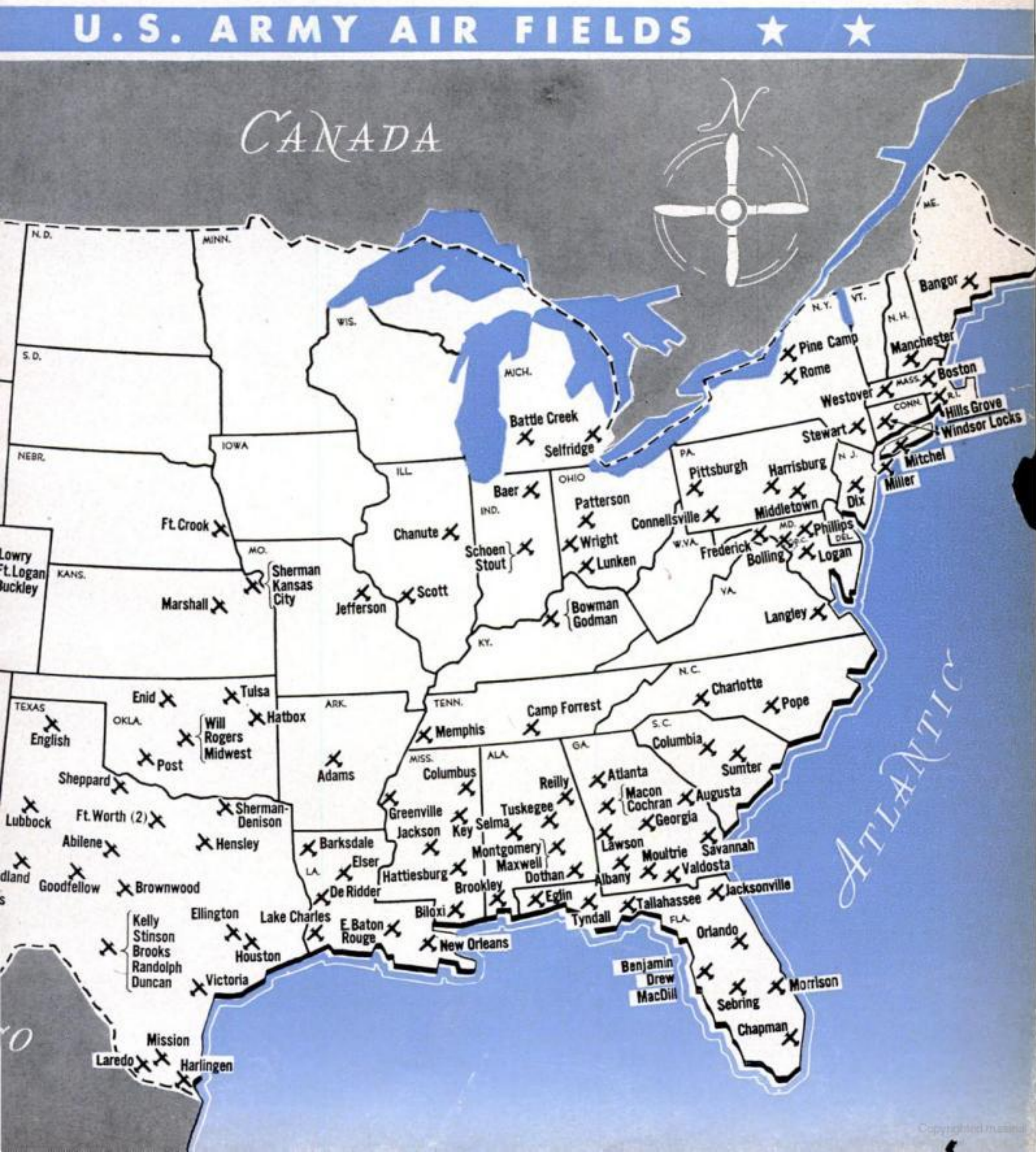
must provide their own power, heating, sewerage, and water services. They must include barracks, hospitals, warehouses, recreation facilities, and even miles of roads and railroad spurs.

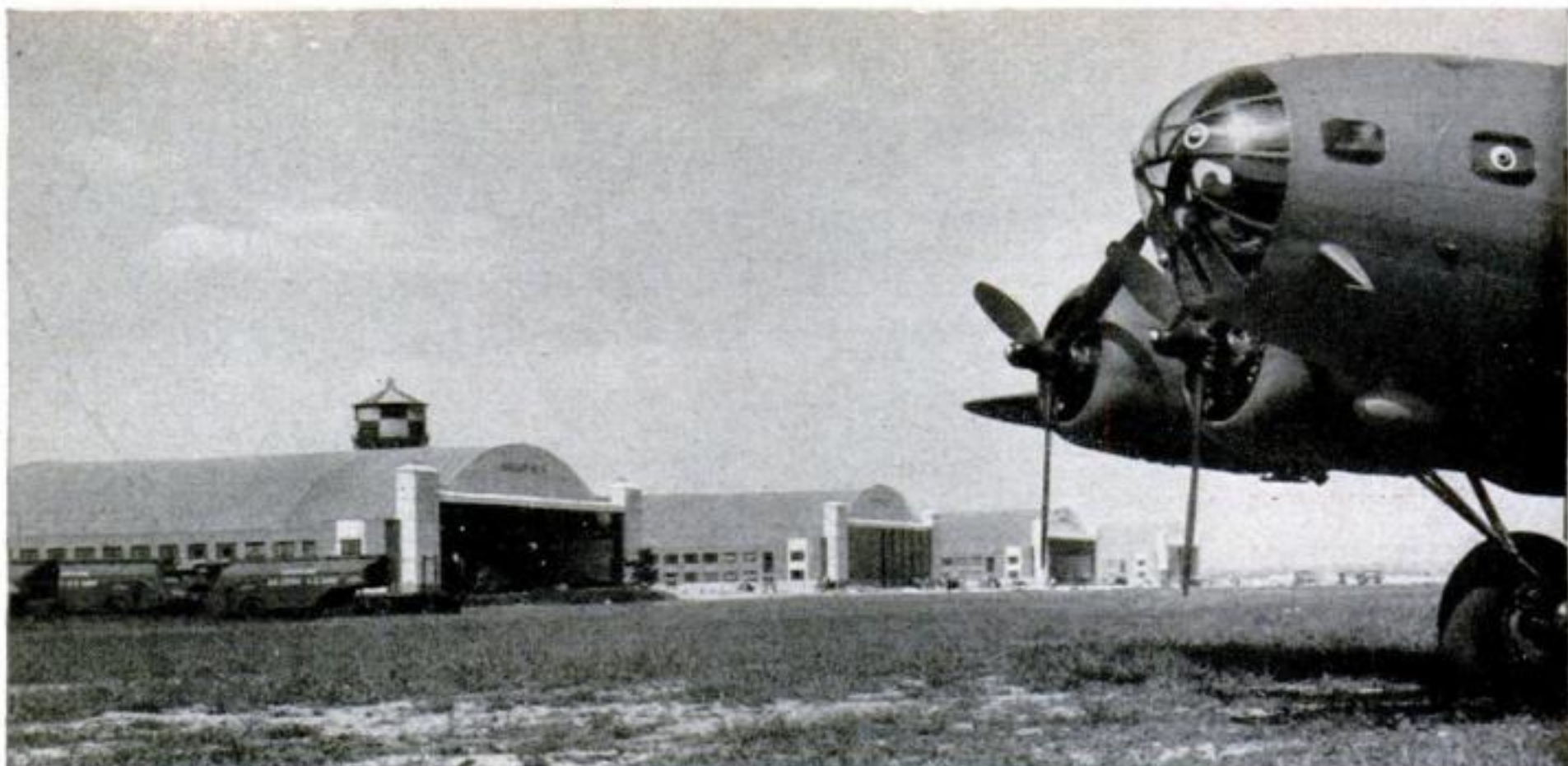
The C.A.A., realizing that America has never taken advantage of its waterways for aviation, is also speeding a program to develop seaplane bases, on lakes and rivers as well as along the coasts. Seaplane bases have many advantages. They cost less to

develop and maintain than airports. Airports can be destroyed by bombs. Water landing areas cannot.

The C.A.A. embarked in the Spring of 1939 on a plan to install seaplane docks on a national scale. The National Youth Administration built the bases to C.A.A. specifications with materials furnished by local communities. Already more than 200 have been completed.

Another recent development which may





From tobacco fields to airport: Westover Field at Chicopee Falls, Mass., is one of the Army's newest

prove to be important to the nation's airport program is the construction of flight strips along federal highways. The first real test of flight strips was projected by Congress in the emergency road bill. The idea was developed by the Army for emergency military landings and as possible points for scattering combat planes in case of attack. Now leaders of civilian flying have become interested, visualizing the use of flight strips for commercial projects and as centers of aviation activity in rural areas. Rent of hangar space would boost farmers' incomes.

The airport program may also be aided by another new idea which promises to reduce the cost of airport construction. That is the use of soil cement for runways. First tried on country roads, soil cement is a method of stabilizing ordinary earth.

The method is simple. The earth is scarified and pulverized with harrows to a depth of six inches. A thin layer of cement is spread over the surface and mixed with the soil. Then water is added with a pressure distributor. The surface is then rolled, covered with a thin bituminous wearing surface and left to dry under straw. It costs about \$1 a square yard, half the cost of concrete. Soil cement is now being tested at the Fort Wayne, Ind., airport. If it proves it can take it, the way will be opened to use soil cement on hundreds of other projects.

It is still too soon to tell how much effect these developments may have on the airport program. But to understand what is going on now in the program it is necessary to know something of how airports have been built in the past in the United States.

Until the C.A.A. got its first appropriation last fall, the Federal Government had con-

sidered that the building of civilian airports was the responsibility of local communities. The C.A.A. had for years been advising municipalities to plan and build systems of airports just as they do park systems. Had this been done, civil aviation would not now be on the spot because of the occupation of so many airports by the Army and Navy.

The failure to heed the C.A.A.'s advice is proving serious in the present emergency, but the blame can not be heaped on the shoulders of city fathers alone. When the aviation bubble first drifted across the national horizon many local governments, in the carefree rapture of the middle twenties, floated long-term bonds and bought up fields for airports. Not much was known about the airport business then, so most of the fields lost money. With the arrival of the



Breaking ground for a military flying field means just that. A lot of dirt has to be moved in grading the long, broad runways and laying down roads

depression they became white elephants.

But the depression also brought federal work relief and public works projects. One of the most obvious places to dump some of these public funds was in airport construction. Some exceedingly valuable facilities were built in this way. By the end of 1941 about \$371,000,000 will have been spent for airports through F.E.R.A., C.W.A., P.W.A., and W.P.A. projects. Now, in the defense emergency, they are beginning to pay dividends.

Only when the war clouds began to blow toward America did the Federal Government decide to give the C.A.A. funds for airports. Because of the limited funds made available, it was imperative to get the most for the least. Hence it was decided that not one C.A.A. penny could be spent for land or buildings. This leaves the responsibility on local communities to provide the sites, erect the buildings, and maintain and operate the fields. The C.A.A. supplies only actual landing facilities such as runways and lights. But local governments, including cities, counties,



Water landings for seaplanes are being developed by a Government program which provides for building docking floats and fuel stations



"Flight strips" alongside highways would provide emergency landing fields. Hangar space for local flyers would give farmers a new crop

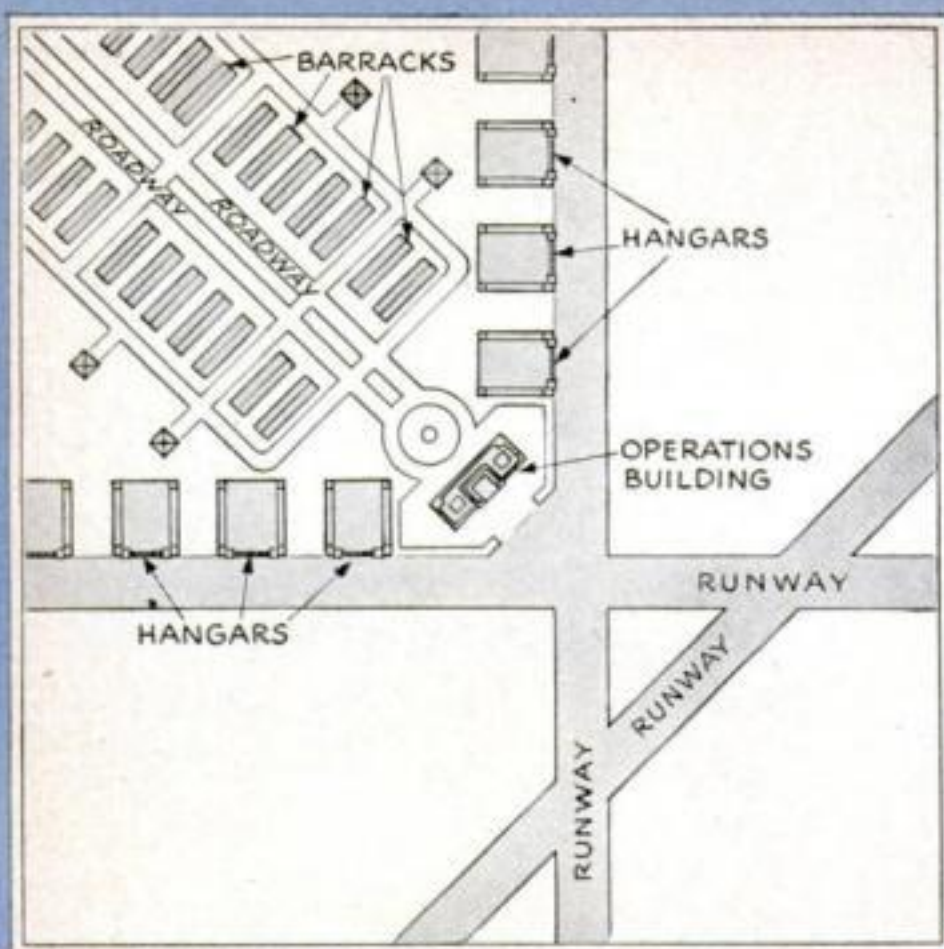


Sometimes it is necessary to strip off loose dirt and sand on the airport area, replace it with topsoil, and plant grass to stop blowing



Landscaping the grounds around barracks and other buildings is a big job. Much of the work is designed to be permanent for use after the defense emergency

THE MODERN MILITARY AIRPORT IS A LITTLE CITY IN ITSELF



This is a typical plan of an Army field, showing arrangement of the runways, hangars, and buildings

WHAT IT TAKES TO MAKE A BIG ARMY AIR FIELD

Flight hangars	Paint and dope bldg.
Concrete hangar aprons	Photo laboratory
Paved runways	Supply warehouses
Communications bldg.	Barracks
Officers' quarters	Mess halls
Fueling systems	Guardhouse
Incinerator	Post office
Central heating plant	Motor repair shops
Water system	Vehicle garage
Electric system	Chapel
Sewage system and treatment plant	Theater and school
Steam pipe system	Parachute drying bldg.
Communications system	Operations bldg.
Roads and railroads	Recreation bldg.
Radio buildings	Officers' club
Magazine area	Link training bldg.
	Hospital unit

HOSPITAL. Provision is made to take care of the health of the thousands of men who will be stationed at the large fields



and states, are falling in line with this plan and the C.A.A.'s long-range program is going ahead to create a network of airports keyed to tomorrow's needs.

And what are tomorrow's needs? For the immediate future they are predominantly military. For the future that may be in store when the fury of the war has burned out, they will be civil and commercial. But civilian needs may be infinitely greater as an aftermath of the present military expansions.

Tremendous new airplane factories, some of them among the largest industrial plants in the world, are now rising. Thousands of skilled mechanics are being trained and employed in aircraft production. Imagine the rate at which these plants and men may some day be able to turn out small training, private



DARKROOM facilities are provided for developing photographs made in aerial mapping

ROADS—as much as 12 miles of them at a large field, are graded and paved . . .



and commercial airplanes! Price reductions will accompany such quantity production, provided of course that a market is available.

By the beginning of 1942 the Army, Navy, and C.A.A. will be turning out pilots at the rate of 100,000 a year. These pilots, together with those who will continue to learn to fly at their own expense, promise to provide such a market to keep aircraft production at a high peak after the war.

If this happens, and many believe it will, we must be certain that the airport system being built for national defense can be salvaged and converted easily to civilian and commercial uses. Aviation experts say that, with a few relatively simple changes, it can.



HANGARS. With more than an acre of floor space, this brick-and-concrete building will house eight big four-motor bombers. Its sliding doors are opened in 2½ minutes by electric motors



PHOTOGRAPHIC LABORATORY includes not only darkrooms but also facilities for storage and repair of aerial cameras



BARRACKS are provided for enlisted men and officers. Other structures include mess halls, administration buildings, recreation halls, theaters, post exchanges, chapels

... and lines must be laid for sewers, water supply, gas, electricity, communications

DENTIST'S OFFICE is a busy place. Health of flying and ground personnel is an important factor in air-force efficiency



Troop Transport Truck and Trailer Go Almost Anywhere



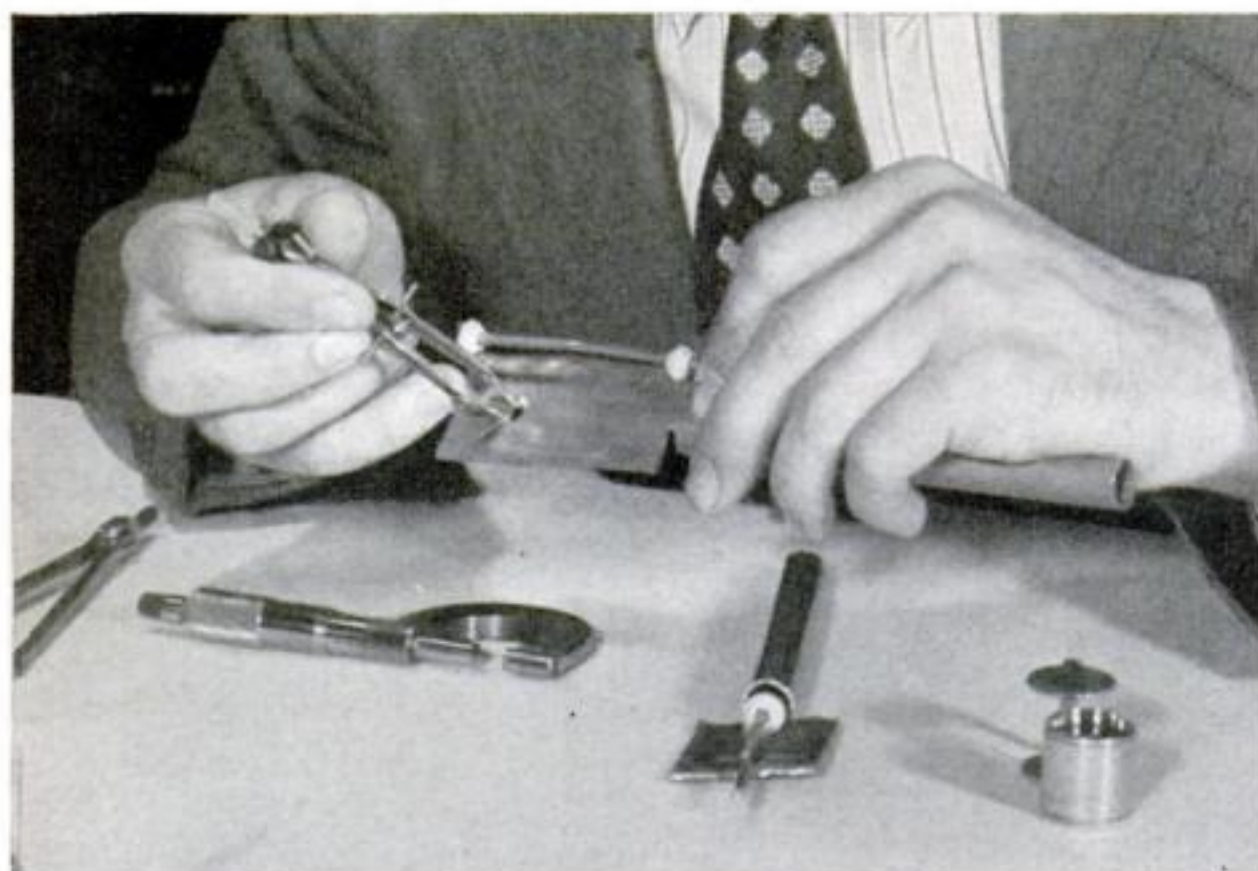
Seventy-five soldiers of the 32nd Infantry, 4th Army, are riding in this rough-terrain 2½-ton truck and its trailer. All wheels follow tracks of the truck's front wheels

An officer points out "arc-ticulated" axle which permits these trailers to roll over rough country. Each axle is independent, permitting wheels in line to stay in track

A NEW U. S. Army troop-transport trailer permits the movement of large bodies of troops over difficult terrain. It was made possible through a type of axle known as "arc-ticulated," developed at Fort Ord, Calif., under the direction of Maj. Gen. Joseph W. Stillwell. The axle permits each wheel of the trailer to follow the same track as the front wheel of the truck, making it possible for the unit to pick its way over difficult places. A truck and trailer can carry 75 men, or 65 with ammunition, food, and supplies for three days in the field.



Lightning is "Fingerprinted" to Identify Kinds of Bolts



Measuring the amount of metal melted by lightning that struck a wireless tower cable. This imprint will be compared with those made in laboratory

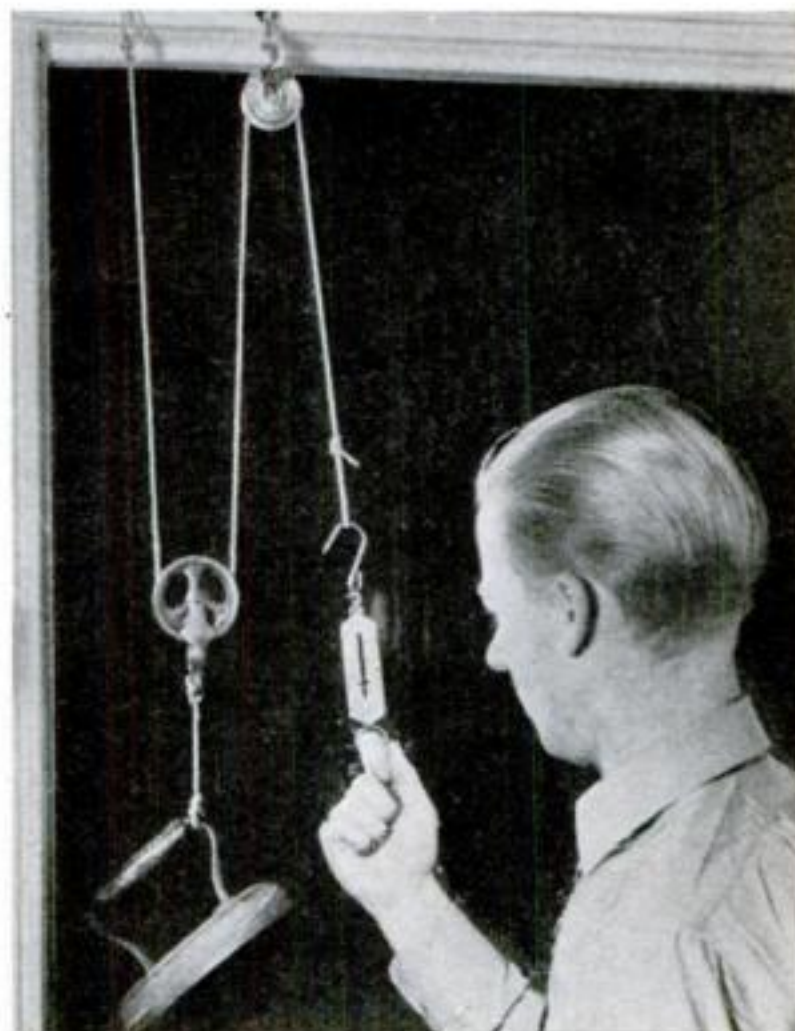
"FINGERPRINTS" left by lightning on metal objects it strikes provide clues to its nature and help design protective devices. At the Western Electric and Manufacturing Company's laboratory at Sharon, Pa., a file of several hundred "fingerprints" has been collected by bombarding lightning rods, power-line conductors, and telephone wires with man-made lightning. The scars left vary with the type of lightning used, and these scars are compared, by means of microscope and caliper, with scars left by natural lightning.

SCIENCE TUNTS

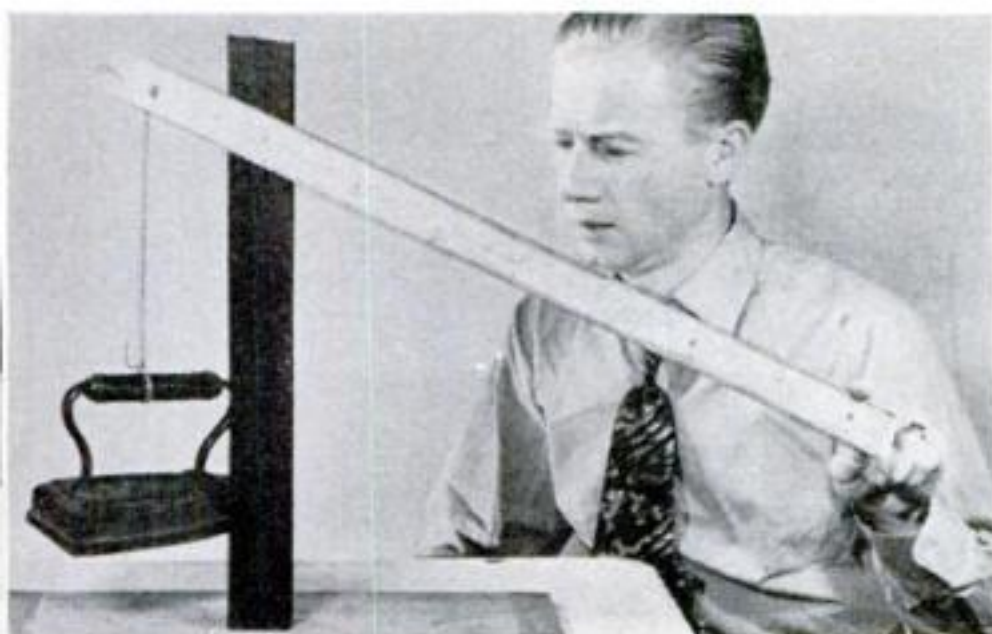
SIMPLE EXPERIMENTS SHOW PRINCIPLES OF ALL MACHINERY

TO PERFORM tasks beyond their strength, and to shorten light but time-consuming work, men long ago invented a few simple machines. Today practically every sort of hand or power mechanism—even as complex as a car or a printing press—consists largely of a combination of those same fundamental devices. Experiments on this and the following page enable an amateur scientist to demonstrate their action.

ROPE AND PULLEYS. In the picture at right, the lower, movable pulley halves the effort required to raise an eight-pound iron. The spring scale registers only four pounds. Above, a fixed pulley does not reduce the needed force, but conveniently changes its direction. The “mechanical advantage,” or multiplication of force, is 2; additional pulleys would increase this ratio, as in a block and tackle. Slower lifting of the weight is the price paid for this advantage.



COMPRESSED-AIR PUMP. In many homes without city water supply or a high water tank, pressure is maintained by compressing air in part of a water storage tank. To demonstrate this application of an old principle, attach long and short glass tubing through a two-hole stopper to a flask of colored water. Pinch the rubber connection of the long tube, and, by blowing into the short one, force about a dozen air bubbles into the flask. Then close the connection to the short tube, open that of the long one, and the water will be forced up the latter by the air pressure in the flask.



LEVERS. A fingertip's touch on the long end of a pivoted bar, at left, easily lifts a heavy iron hung from the short end. Here is one of many forms of the versatile lever, perhaps first used to pry up boulders and move heavy logs. Crowbars, pump handles, nutcrackers, and pliers illustrate levers used to multiply force; paper shears and lazy-tong devices represent levers used for lengthening range of movement, when increase of effort is too slight to matter. Comparative distance of load and applied force from the pivot or fulcrum determine exactly what the mechanical advantage will be.

INCLINED PLANE. Barrels and drums, too heavy to lift bodily, may be loaded on a truck by rolling them up a slanting plank. At right, the principle is shown with a toy auto weighted to two pounds, and drawn with a spring scale up an inclined plane two feet long with a six-inch rise. The scale will register half a pound (plus a small amount for overcoming friction). Neglecting friction, the mechanical advantage of an inclined plane is directly proportional to its length, for a given height.

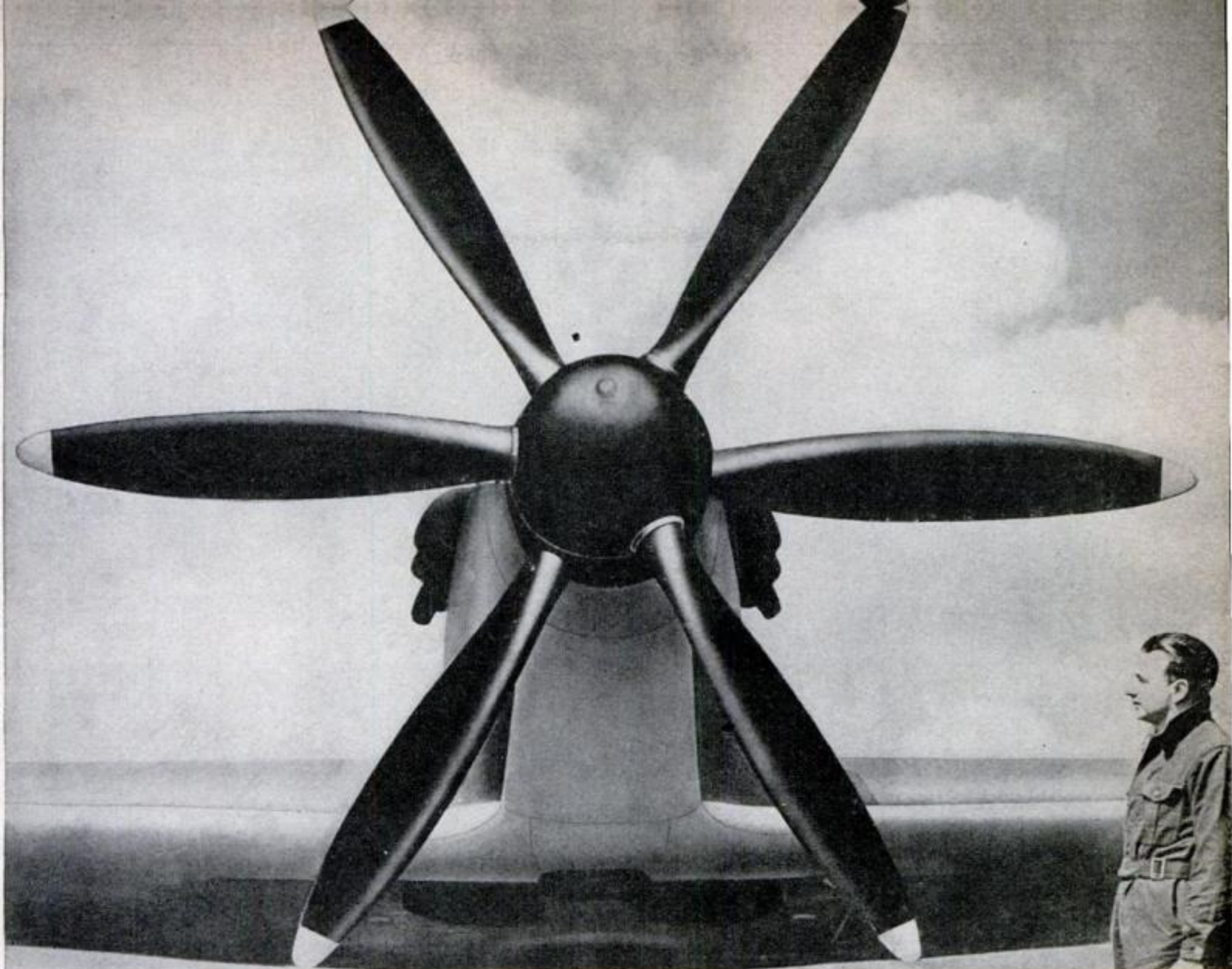


THE SCREW. Fundamentally, a screw thread is merely an inclined plane wrapped around a cylinder or cone. The force with which a wood screw pulls together a pair of boards shows the usefulness of this simple machine. Turn a screw by means of an extension bar, as in a jack-screw or letter press, and the result is a tremendous mechanical advantage. The pull of one finger, on a cord wrapped around the seat of a piano stool, suffices to raise the formidable load illustrated. In this case the principle of the screw is combined with that of the wheel and axle, described below.

WHEEL AND AXLE. Steering wheels and windlasses exemplify this modified sort of lever. Turning a large wheel exerts strong force on an axle or smaller wheel; conversely, as pictured, a strong effort on the smaller member is needed to lift a weight by the larger one. Drive belts and gear trains are wheel-and-axle forms with the driving and driven members on different shafts, instead of the same one.

THE WEDGE. Applied in axes, chisels, knives, and pins, this is simply a movable inclined plane. Light taps on a wooden wedge, as pictured below, raise a platform supporting a man's weight. Heavy machinery similarly is lifted into place. But because of its considerable friction, resulting in wasted effort, a machine designer would prefer levers or other movements of equal mechanical advantage.





A British test installation of the contra-prop system. Two 3-blade propellers turn in opposite directions

Two Propellers in Tandem Turning in Opposite Ways Give Warplanes New Speed

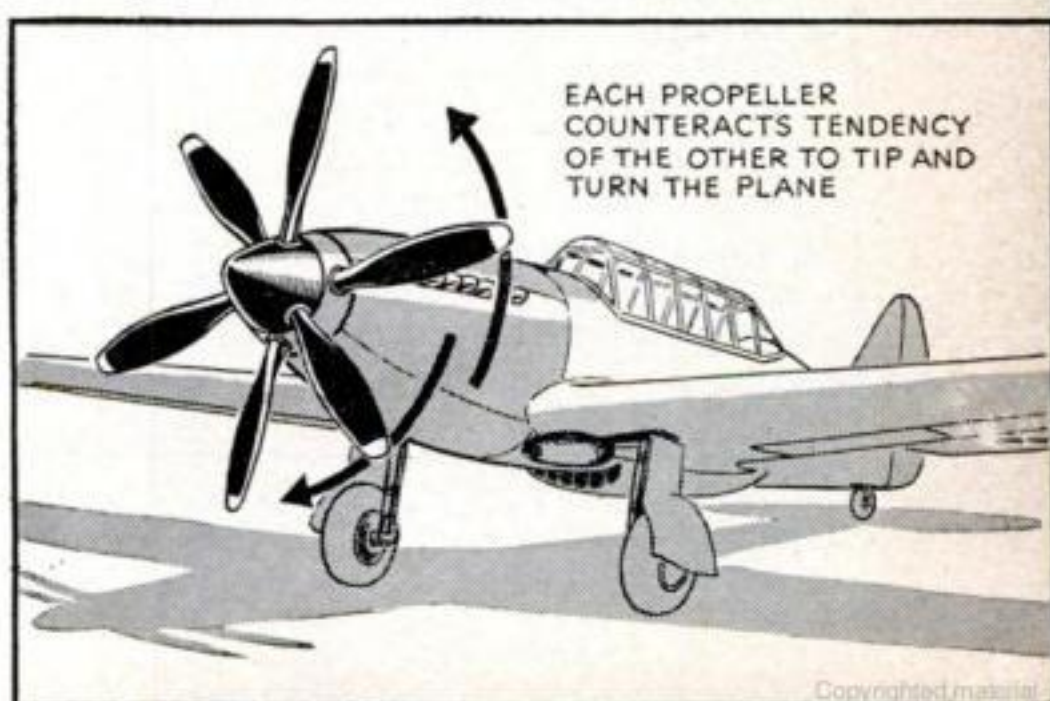
TWIN PROPELLERS, whirling in opposite directions on concentric shafts, are an expected innovation on at least five experimental warplanes of 1942. Current reports indicate that all leading U. S. propeller makers are making the "contra-prop" airscrews, and that they will boost cruising speeds, to say nothing of maximum speeds, well above the 400-mile-an-hour mark.

An Italian racing plane first used the tandem-propeller system 12 years ago. Since then, various designers have toyed with the idea. But its large-scale adoption has awaited present demand for motors of 2,000 horsepower and upward.

"When horsepower increases," explains Robert J. Woods, designer of the Bell Airacobra pursuit craft, "the plane requires either a longer prop or more blades. Twelve

feet is pretty much the limit for prop diameter, and more than four blades on a propeller interfere with each other. So the next thing for the engineer to do is to get two propellers." In addition, he points out, the normal tendency of a single propeller to tip the craft is counterbalanced by the opposite rotation of the second one in the tandem arrangement. Contra-prop installations may be made not only on conventional plane types but also on "pusher" designs with the propellers behind the engine.

The diagram below shows how the two props counterbalance each other's rotation and so remove the tendency of the plane to tip and turn to one side

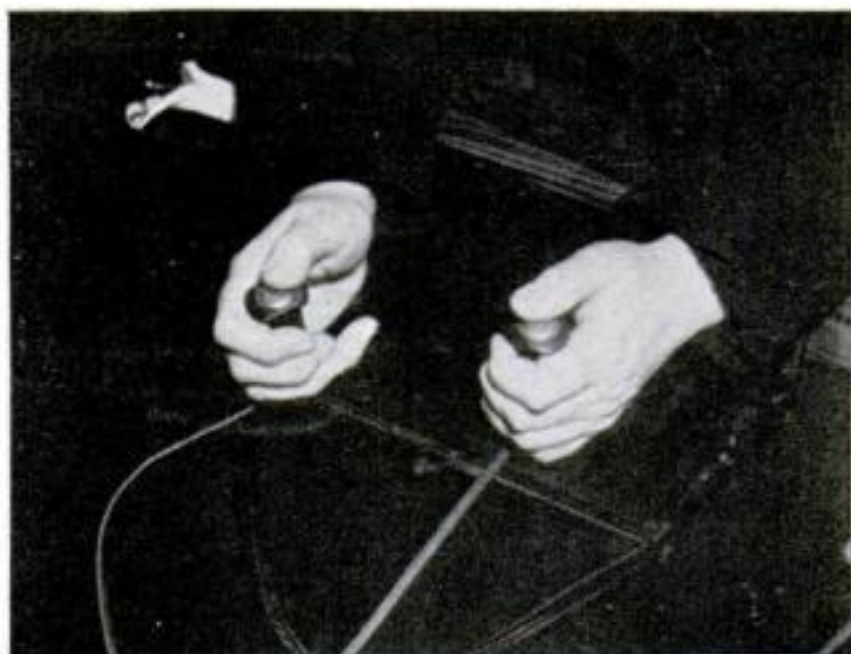


Program Analyzer Supplies Record of Audience's Reactions



Each member of a test audience receives red and green reaction buttons and instructions on how to use them

HOW audiences like radio programs is determined by a program analyzer developed by Dr. Paul Felix Lazarfeld, of Columbia University, and Dr. Frank Stanton, of the Columbia Broadcasting Company. To each of a selected studio audience a pair of buttons is given, one for each hand, one green, and one red. When a person likes the program, he presses the green button; when he doesn't like it, he presses the red; if he is neutral, he presses neither. Each pressing and releasing is recorded on a moving tape to provide a continuous record of reactions.



Pressure on the green button, above, means the program is going over; on the red, that it isn't. A continuous record of reactions is transferred to tape by the machine below



Two-Car Diesel-Propelled Train Provides Full-Length Luxury

LUXURY of a full-length train is found in the two-car, Diesel-powered "Prospectors" of the Denver & Rio Grande Western Railroad. Sixty-two passengers are accommodated, with reclining coach seats for 44 in the first car and berths for 18 with dinette, dressing rooms, and observation lounge in the second.



ARMY'S SMOKE THROWERS

SCREEN
TROOP
MOVEMENTS



TAKE an enemy by surprise, and he is already half defeated. How smoke screens keep him guessing whether you are attacking, withdrawing, receiving reinforcements, or shifting troops was recently demonstrated at Edgewood Arsenal, Md. Observers saw in ear-splitting action the Army's latest smoke-throwing equipment, developed by its Chemical Warfare Service for every

situation to be encountered in modern war.

The principal weapon of the chemical troops, their 4.2-inch mortar, is ideally suited to the modern style of mobile fighting. Light, speedy trucks and rubber-tired hand carts whirl the mortars into position. Two to five minutes more, and they are set up and firing 25-pound projectiles containing smoke or other fillings. Dropping a shell



Firing a smoke projectile with the latest 4.2-inch mortar. The shell is dropped down the muzzle, as at left, and the four men of the crew fall away. Note rifling in photo above





Mobility makes the mortar ideal for fast-moving modern war. It is rolled into place on its two-wheeled rubber-tired carriage . . .

Bags of earth help to steady the standard supporting the barrel. Periodic checks with a detachable sight show if it has shifted



. . . and set up for action in only two to five minutes, depending upon whether or not an emplacement has been prepared for it in advance. Here it is ready for firing

Below is a close-up of a shell being inserted in the muzzle. The black sheets encircling the base of the projectile contain the propelling charge, as seen in the drawing

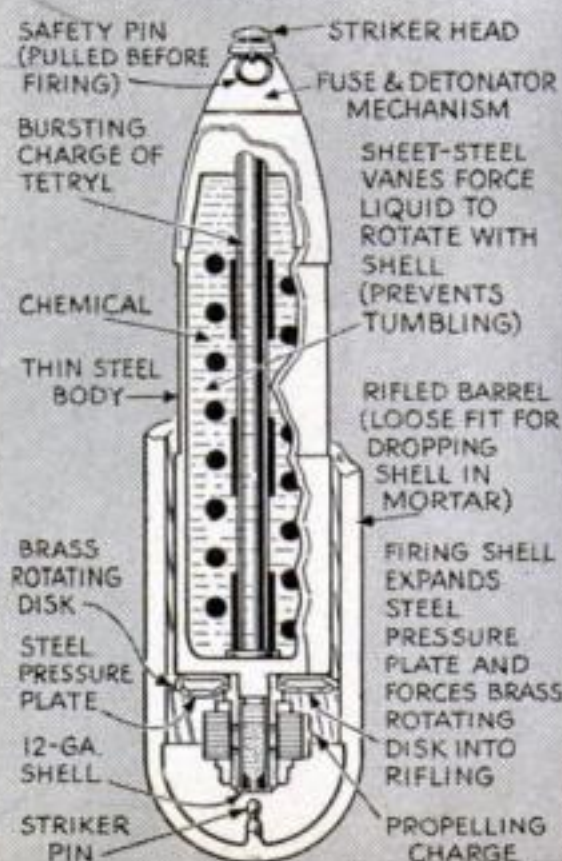


into the barrel automatically explodes the propelling charge and sends it on its way, so that the mortar fires as fast as it can be fed with ammunition.

A rifled barrel, a major improvement in the mortar, now imparts a whirling motion to the shell to steady it in flight. Consequently the latest design has a maximum range of 2,400 yards—more than double the performance of earlier smoothbore types. To accomplish this, a brass ring called a rotating disk encircles the base of the shell. It just clears the barrel rifling, so that the shell will drop smoothly to the bottom of the mortar. Explosion of the propelling charge, acting against a steel pressure plate, then expands the brass disk to engage the rifling—a clever solution of a perplexing mechanical problem.

Another type of smoke thrower, the Livens projector, fires only once from a single emplacement, in batteries

4.2-in. Chemical Shell

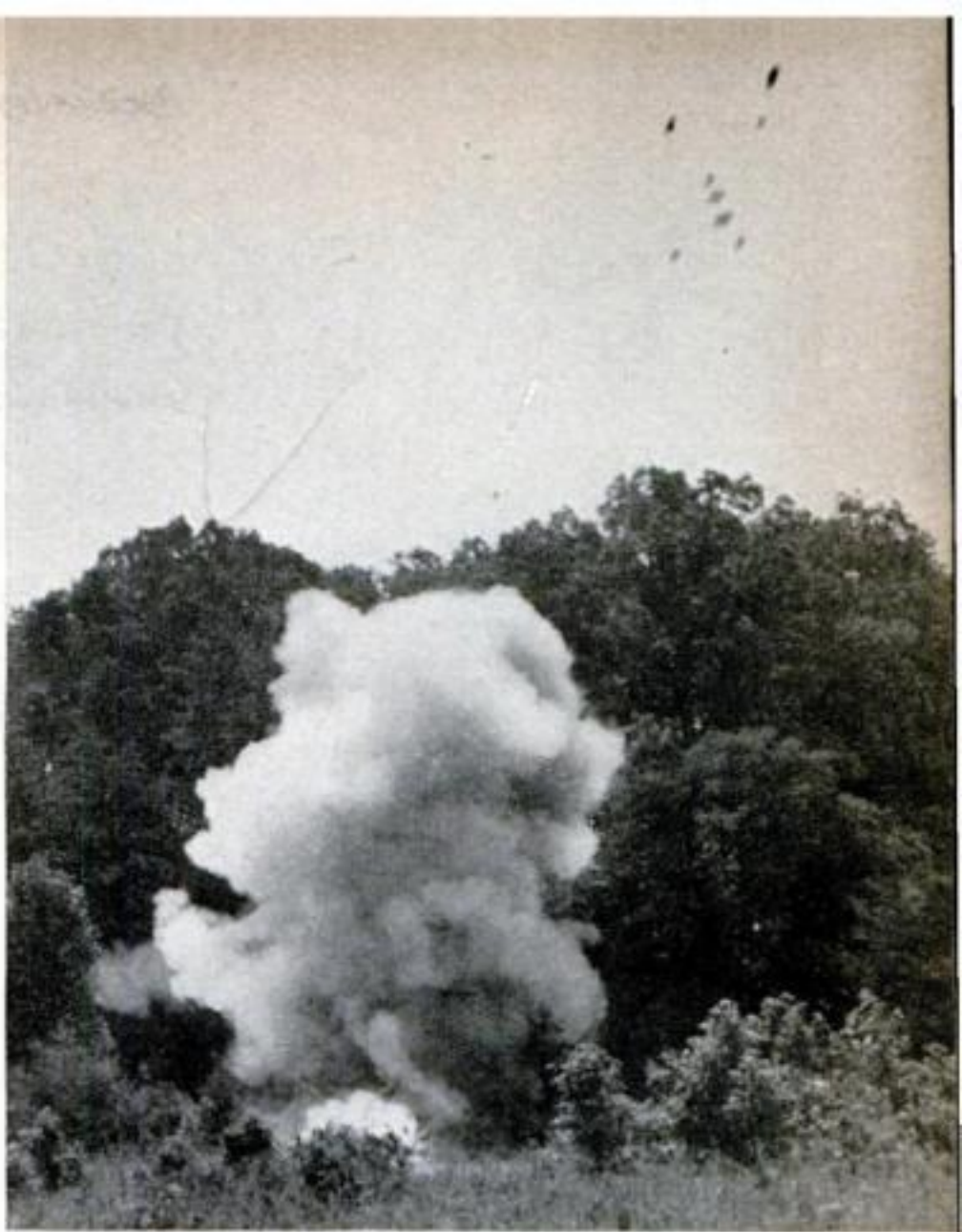


of 25 or more, and so is best suited to trench or "positional" warfare. Shells used for training contain a smoke mixture. On a battlefield, either smoke or casualty-producing fillings may be used. In preparation for a broadside, the stubby projectors must be dug in, wired to make a complete circuit, and loaded under cover of darkness. A hand-pumped detonator resembling those used in quarry blasting sets off all the projectors at once. Plainly visible in flight, their special 63-pound projectiles resemble tumbling watermelons, as they are hurled to a maximum range of 1,450 yards.

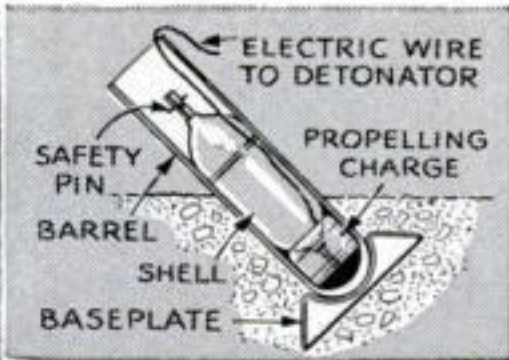
Unlike mortars and projectors, smoke pots depend upon a favorable wind to put smoke just where it is wanted, but such an opportunity cannot be overlooked. The Army's 14-pound type, ignited by hand or electricity, releases grayish-white smoke of high obscuring value for more than six minutes.

Livens projectors are shown in action at the right. The projectiles, looking like tumbling watermelons, may be seen in flight, followed by fragments of the charge boxes and powder bags from emplacements . . .

. . . which are prepared as shown here. Below are the charge box and powder bags containing the maximum propelling charge. Powder bags are put in the charge box, which is then inserted in a projector as seen at the right. Because they have to be planted and wired in advance, Livens projectors are suited only to "positional" use



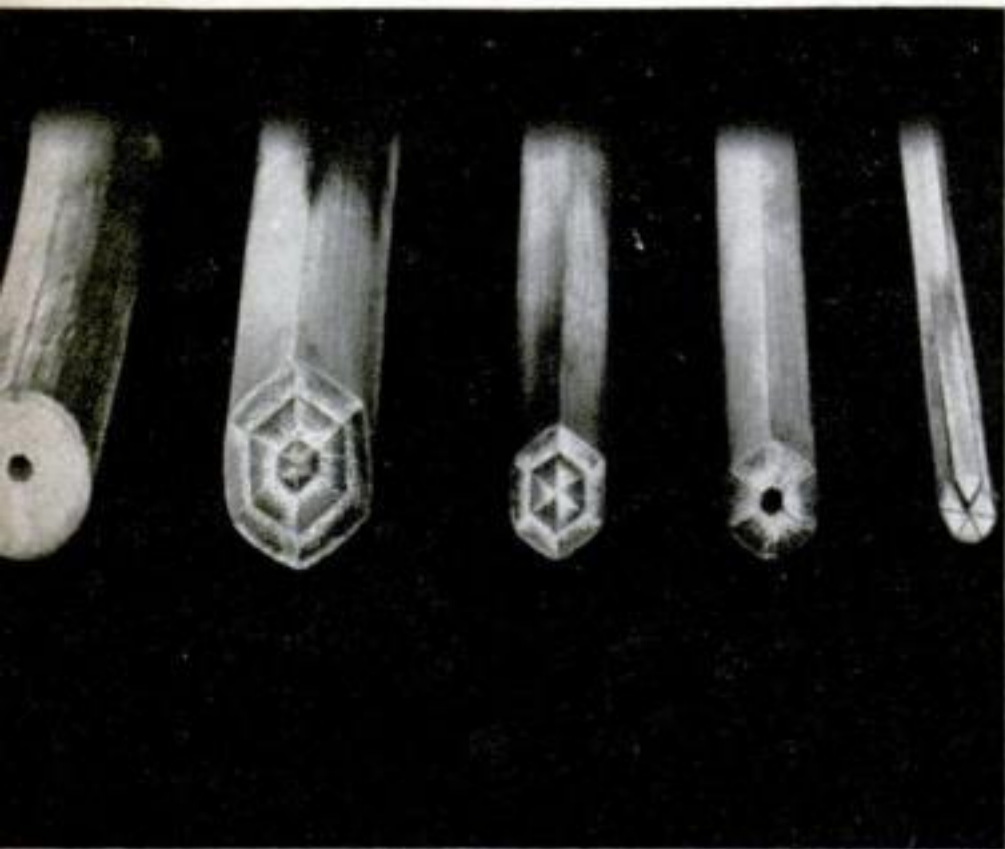
Now the 63-pound projectile goes in. A battery of 25 or more projectors is set off electrically at one time by the use of a hand-pump detonator of the type used in blasting. Just before firing, a soldier makes the rounds and removes the safety pins, which are counted by an officer to insure against "duds"



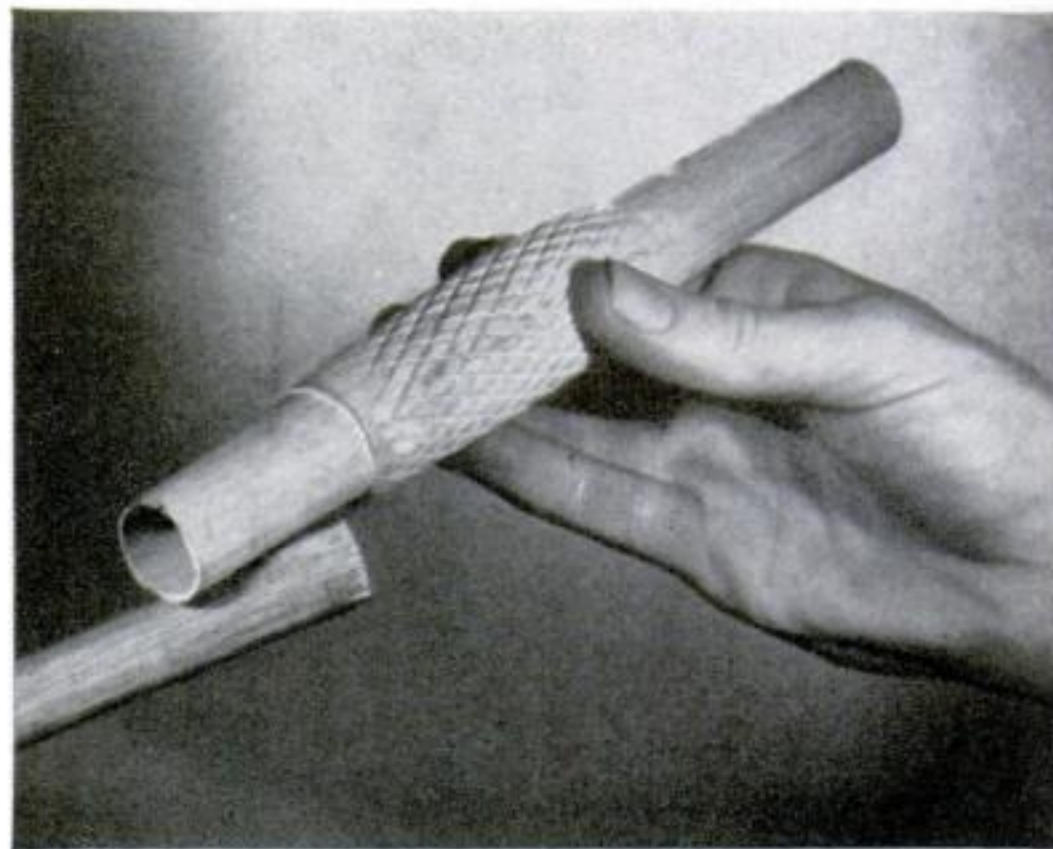
Surf-Rod Making

TRICKS of the trade used by skilled workers in producing surf-fishing rods are revealed in this series of detailed photographs. Step by step, they show how a seven-foot piece of hexagonal bamboo and a few fittings are transformed into the finished rod. By using cord in place of fine thread, the photographer has illustrated the manner in which the experts produce their invisible knots, by means of a slip loop,

when winding silk to hold the grip and guide. Coated with silk preserver and varnish, the wound silk remains solidly in place. A strip of adhesive tape simplifies the job of attaching the stainless-steel guide to the rod. Strapped over one arm of the guide, it holds the fitting in place while the silk is wound over the other arm. So detailed are the photographs that they could guide you in making a rod of your own.



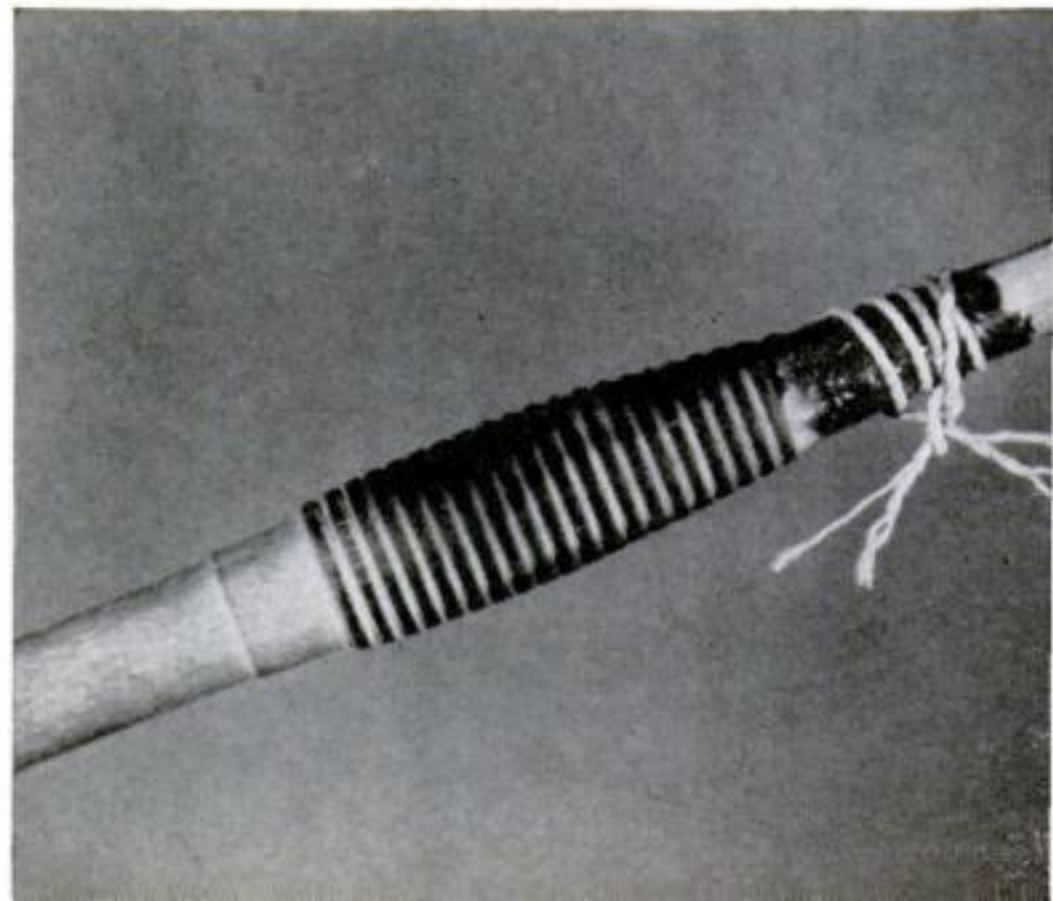
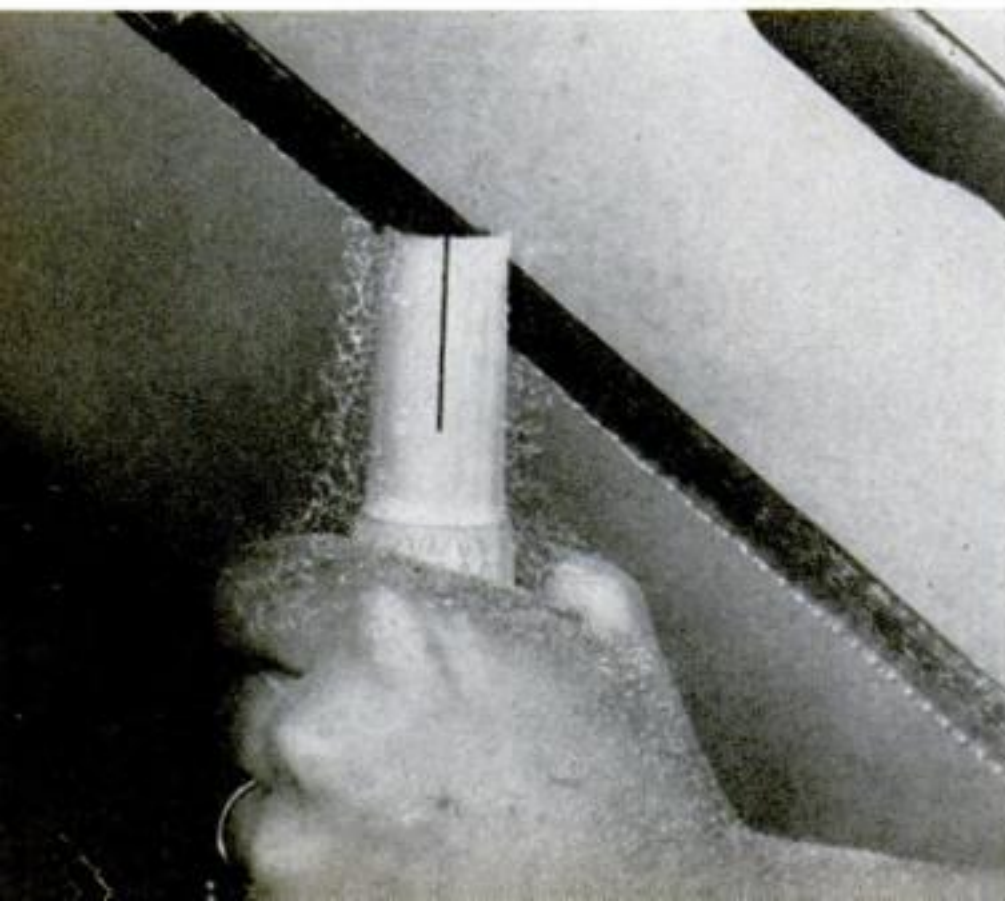
Split bamboo for surf rods is made of Chinese cane (left) split in strips and glued together. A triple-built rod has 18 strips; double-built, 12 strips; the conventional rod, six strips



Here is the wooden grip, ready to be fitted to the end of the rod. The hexagonal bamboo must be rounded to conform to the round hole in the grip. This is done by filing down the corners to get a snug fit

The tip or tapered end of the grip is now slit with a hack saw in three evenly spaced places. This gives six facets to match the hexagonal shape of the bamboo when it goes on the tip...

... as shown below. Before inserting in the grip, glue is spread on the filed portion of the bamboo. Lashing of the grip facets to the bamboo, drying, and cleaning off excess glue complete the operation

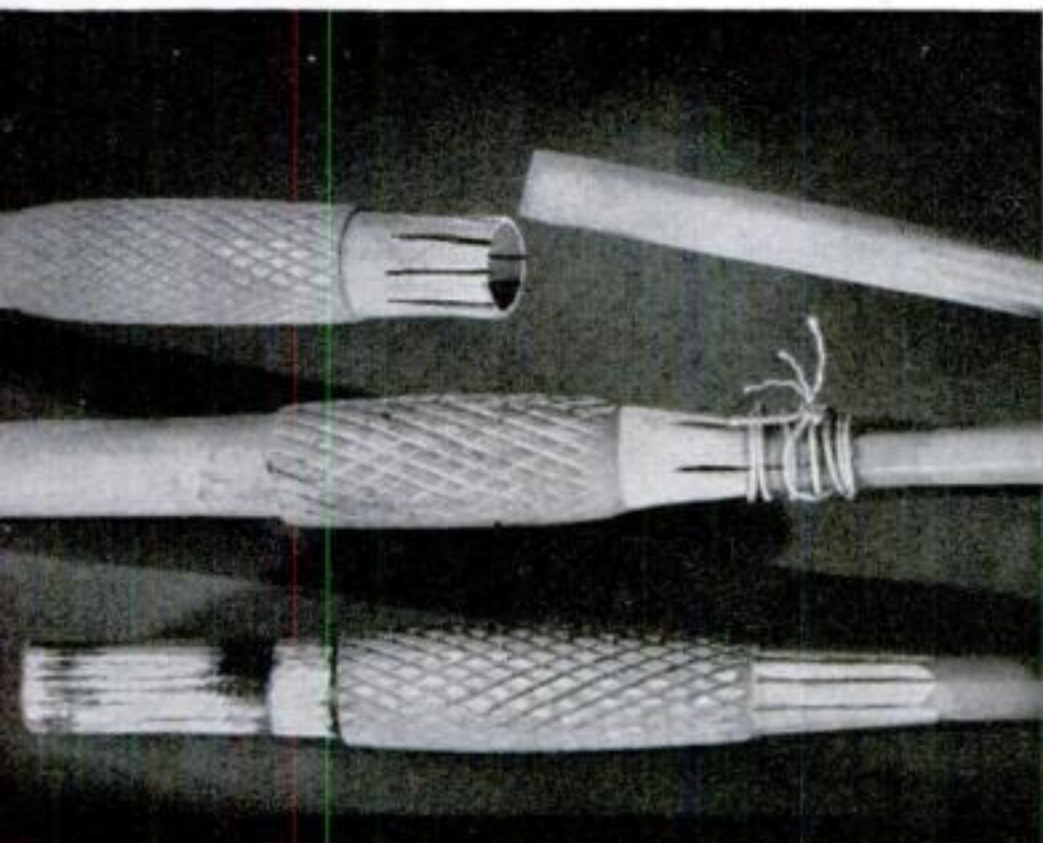




The next step is to file off the grip flush with the tip so that wood and bamboo blend imperceptibly. Glue is not used anywhere except in attaching grip to tip



To mount the butt cap, heat ferrule cement and spread it generously on the place prepared for it. Then slip the cap into place for a snug fit



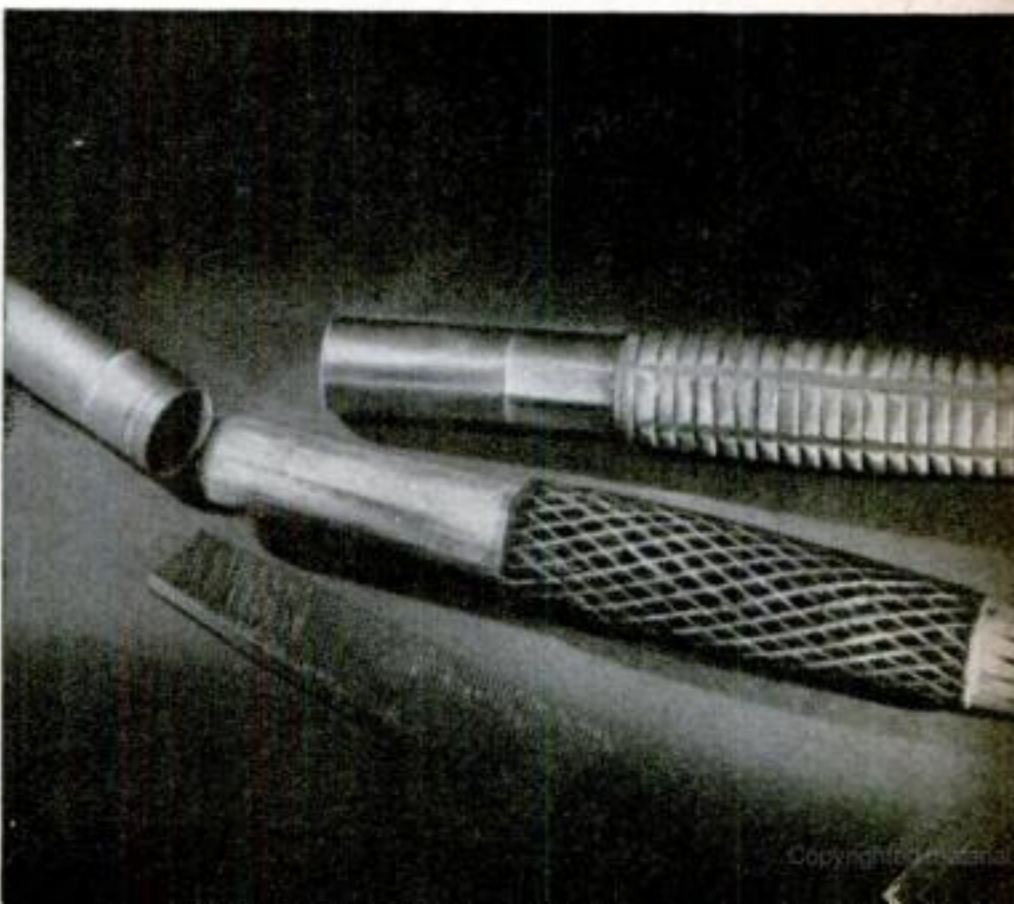
Three stages in the mounting of the grip as described in preceding pictures: In the first, the grip end is slotted; in the second, the grip is glued to the tip and its facets lashed; in the third, lashings removed



Now we are ready to mount the male ferrule. The grip is first filed down to accommodate the ferrule, which should have been selected carefully for size when purchased at a sports store

Again hot ferrule cement is applied and the ferrule is slipped into place on the grip. After some time has been allowed for drying, excess cement may be chipped away to make a clean joint with the grip

Below are shown a grip prepared for mounting the male ferrule, and another with the ferrule in place. The ferrule is heated slightly before it is slipped on, to expand the metal (Continued)

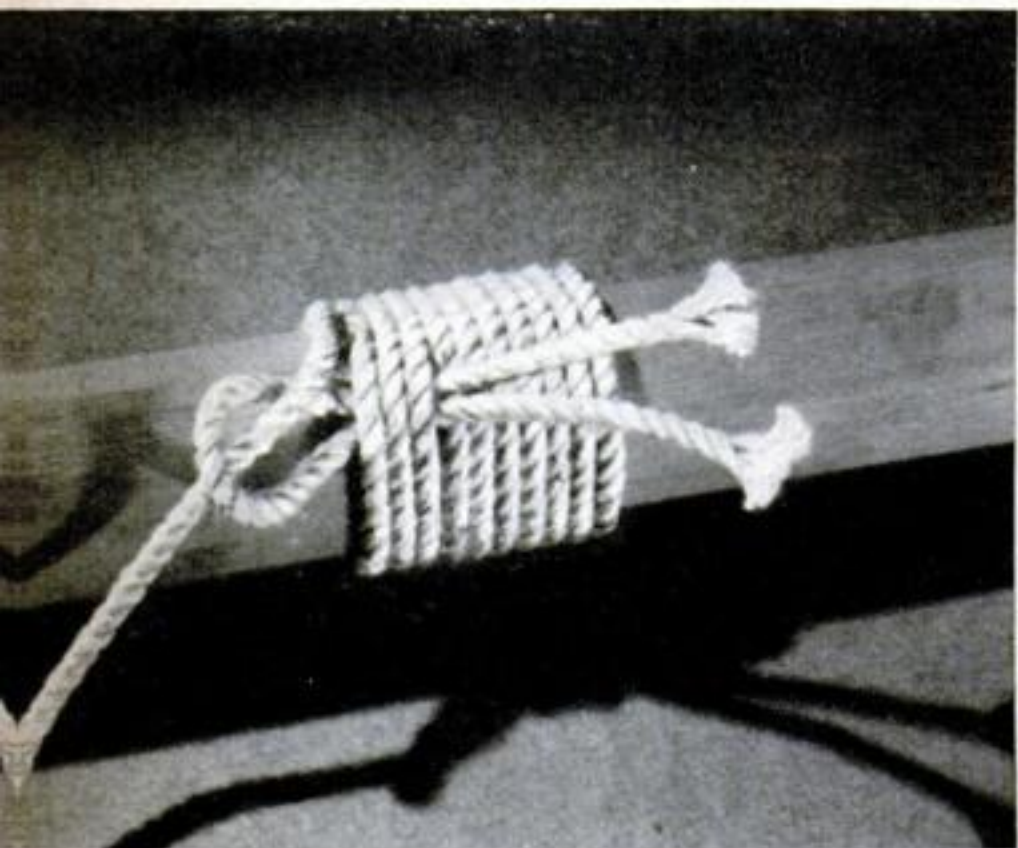




Now the reel seat is mounted on the butt. Here some more filing is necessary. The stainless-steel offset tip will be cemented on after . . .



. . . the winding of the grip, which is illustrated here with heavy cord instead of fine silk to show the slip loop. This is how the winding is started



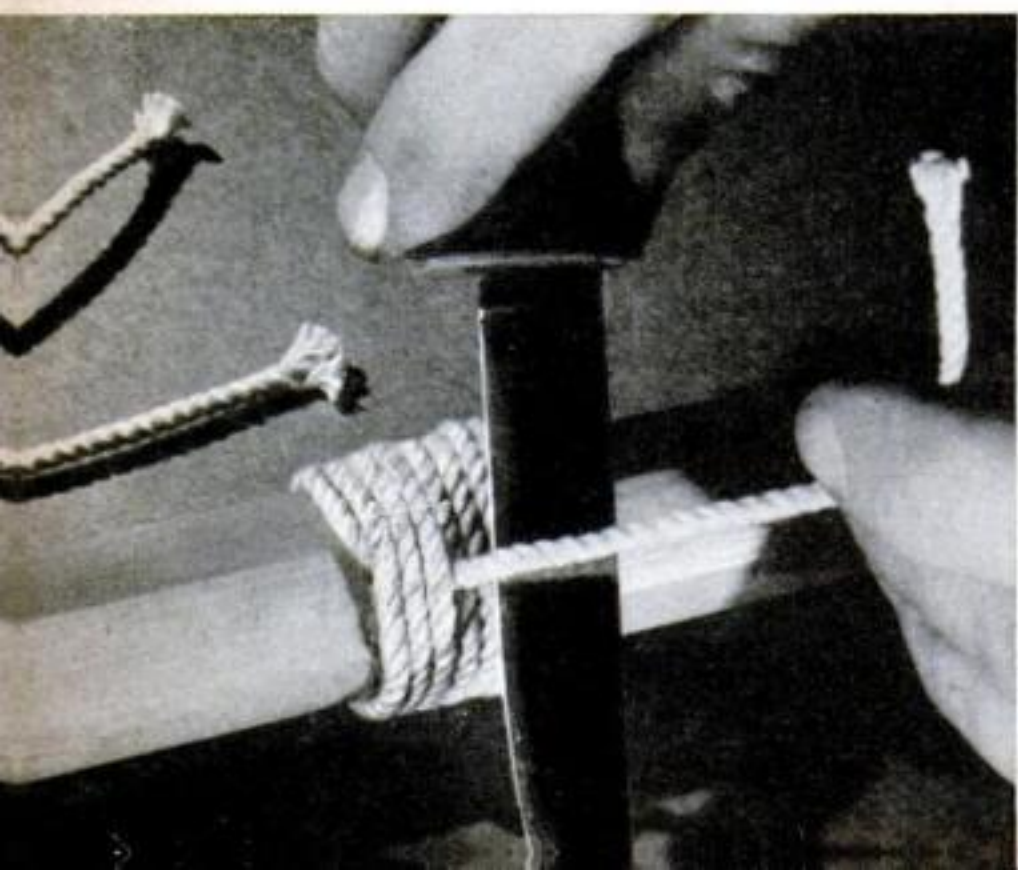
Near the end of the winding, which should be 4 to 12 inches long, a small loop is laid as shown and the winding is continued on top of it. Then the end of the silk is passed through the loop

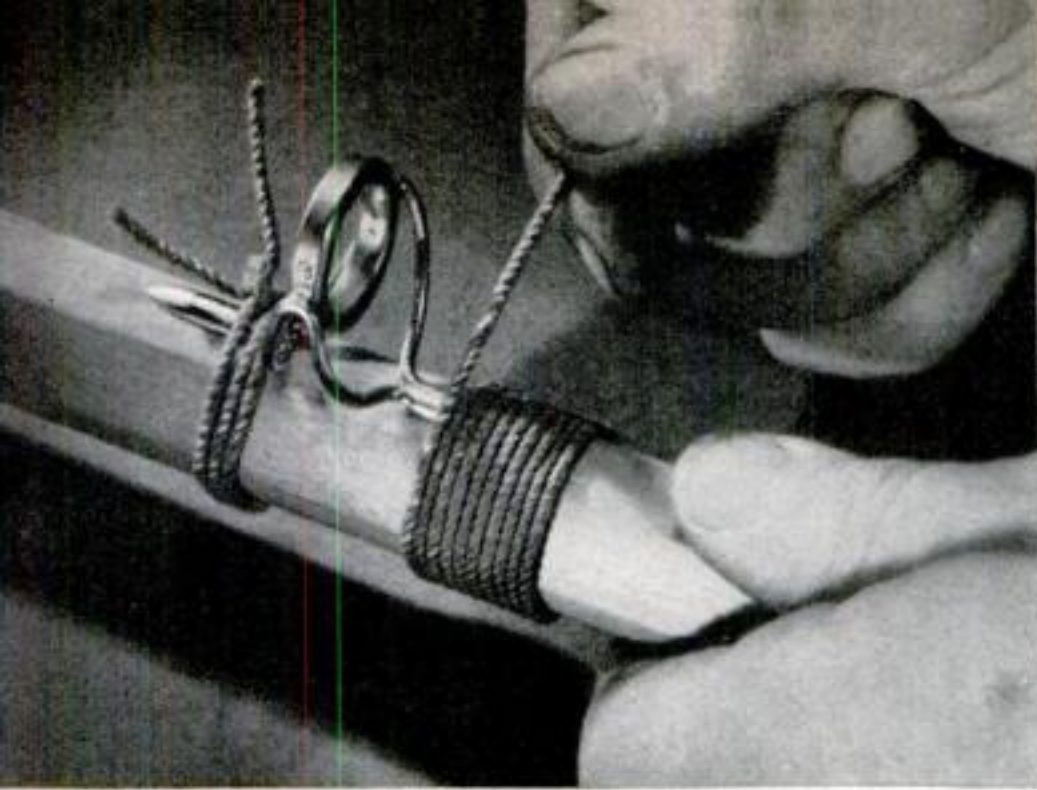


. . . and drawn underneath the overlapping turns. Any space left between the strands of the winding may be closed up by pushing the strands together with the fingernail to produce a close, smooth effect

Now the end of the winding is cut off close. When executed in silk, this slip loop makes an invisible tie that is self-sufficient and does not owe its holding power to varnish or . . .

. . . silk preserver, which is being applied below. A small brush may be used, or a pipe cleaner as illustrated. All silk windings on the rod get this treatment, which protects them from discoloration

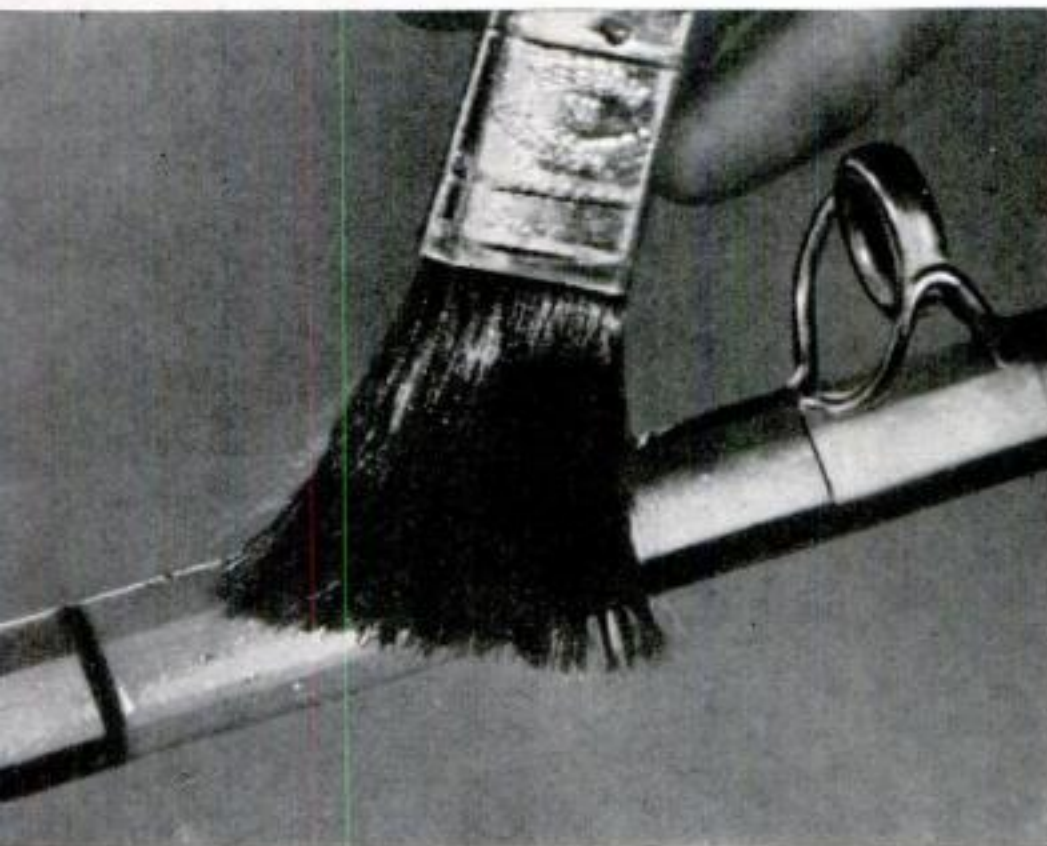




To mount the stainless-steel guide, one arm is held on the rod with cord or adhesive tape while the other is wound with silk in the same manner as the grip



Heating prepares the stainless-steel tip for cementing on the top of the rod, which is filed to receive it. The base of the tip is then wound



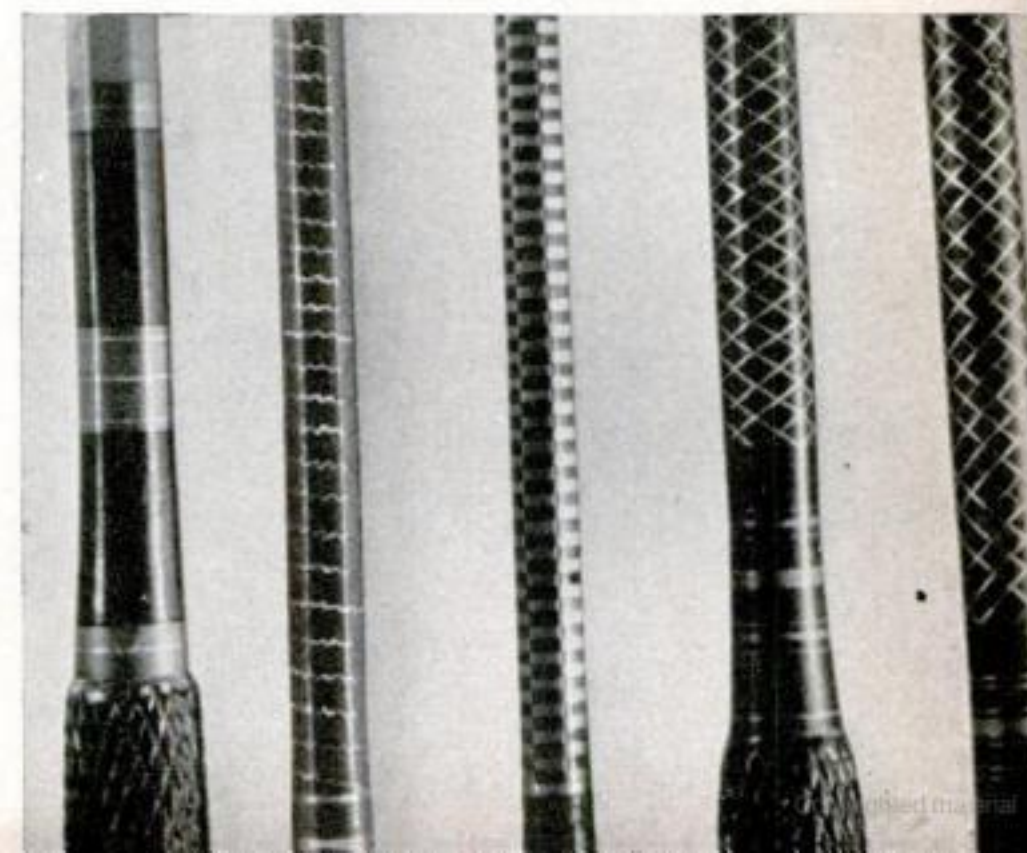
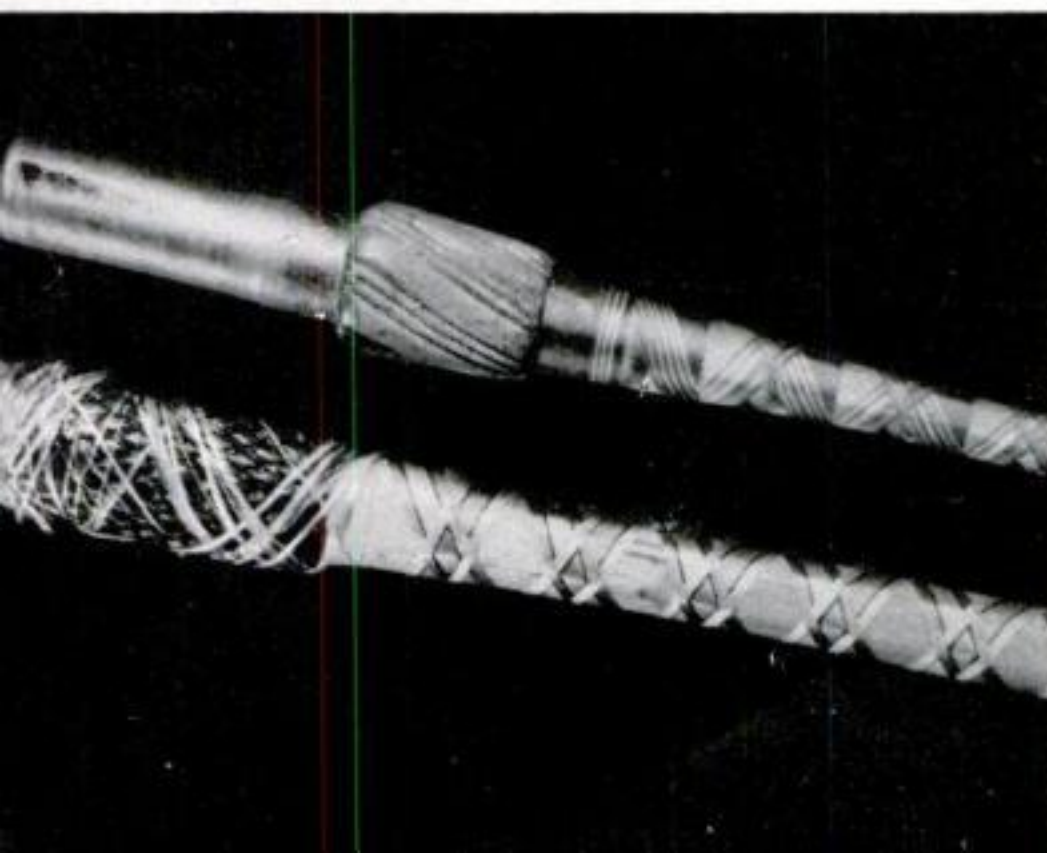
Varnishing is important, to preserve the rod from damage by weather and water. At least five coats should be applied, using even, downward strokes to eliminate air bubbles. Do not cover too much at once



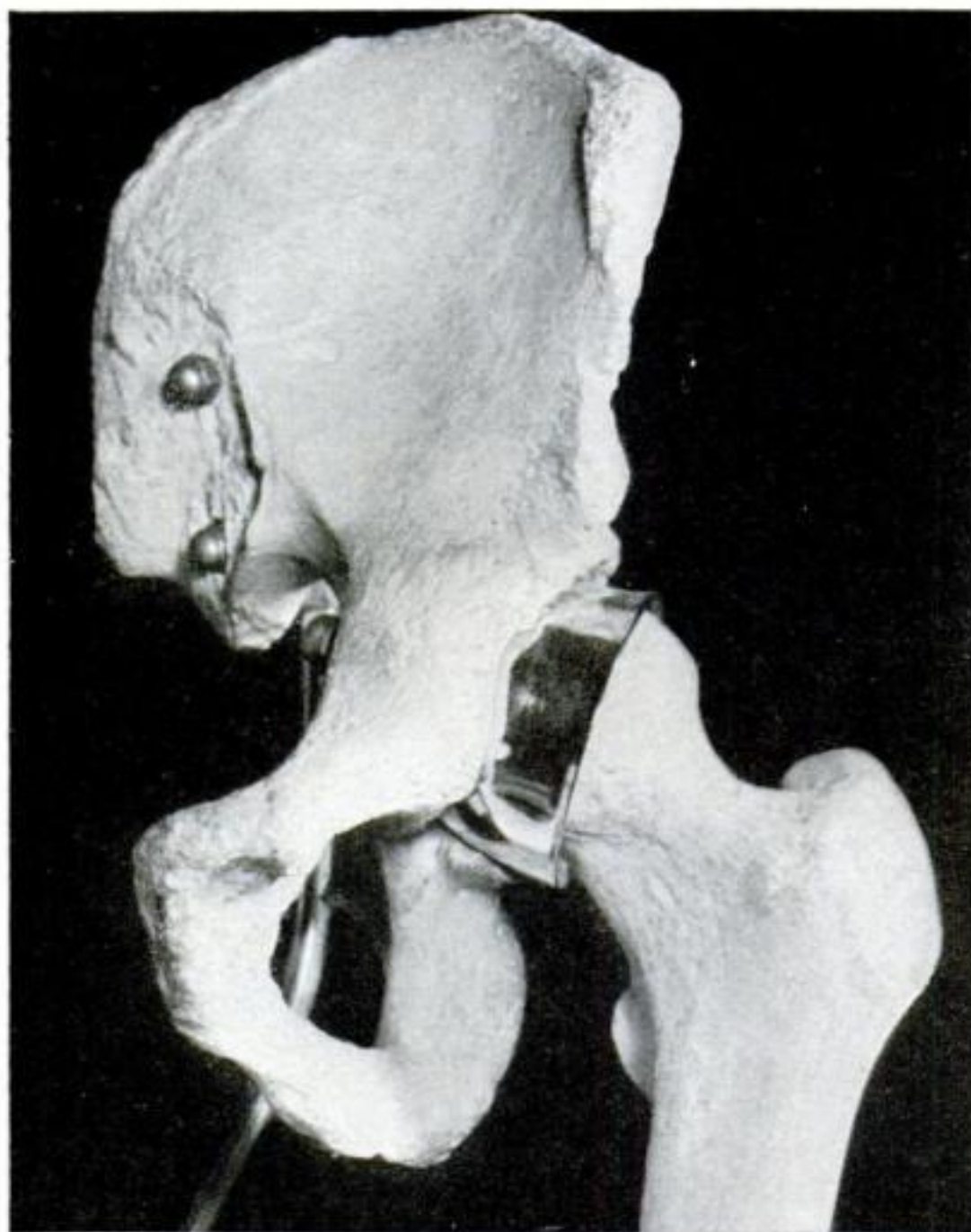
Before the last coat of varnish is applied, the rod is allowed to dry thoroughly and is rubbed down with steel wool. With the final coat on, the rod is rubbed down with pumice and water

While the windings described are all that are needed to strengthen the rod, additional windings are often used to beautify it, and special effects are possible with more difficult windings like those shown here . . .

. . . and here. For proper care, any rod should be given a new coat of varnish every year, dried after each use, kept away from steam heat, and hung from its tip whenever it is not being used



Metal That Mends Bones



A cap of Vitallium, inserted in the hip as shown above, enables a patient long bedridden with arthritis to walk again

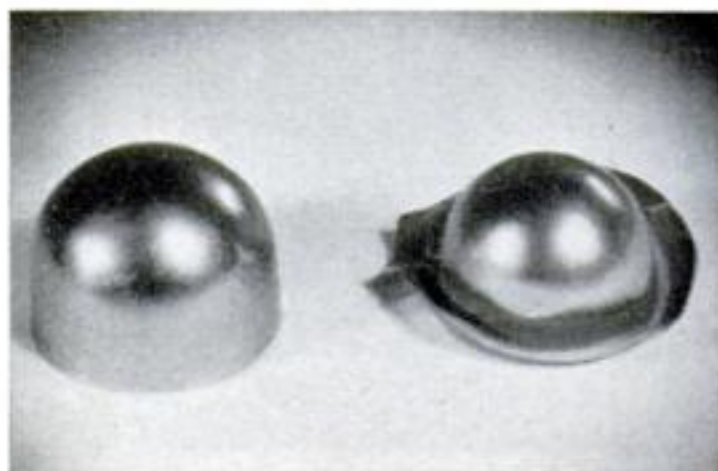
The workman below is polishing up a Vitallium hip cap in the factory. The new alloy is the first metal ever produced that has all the qualities required for surgical carpentry



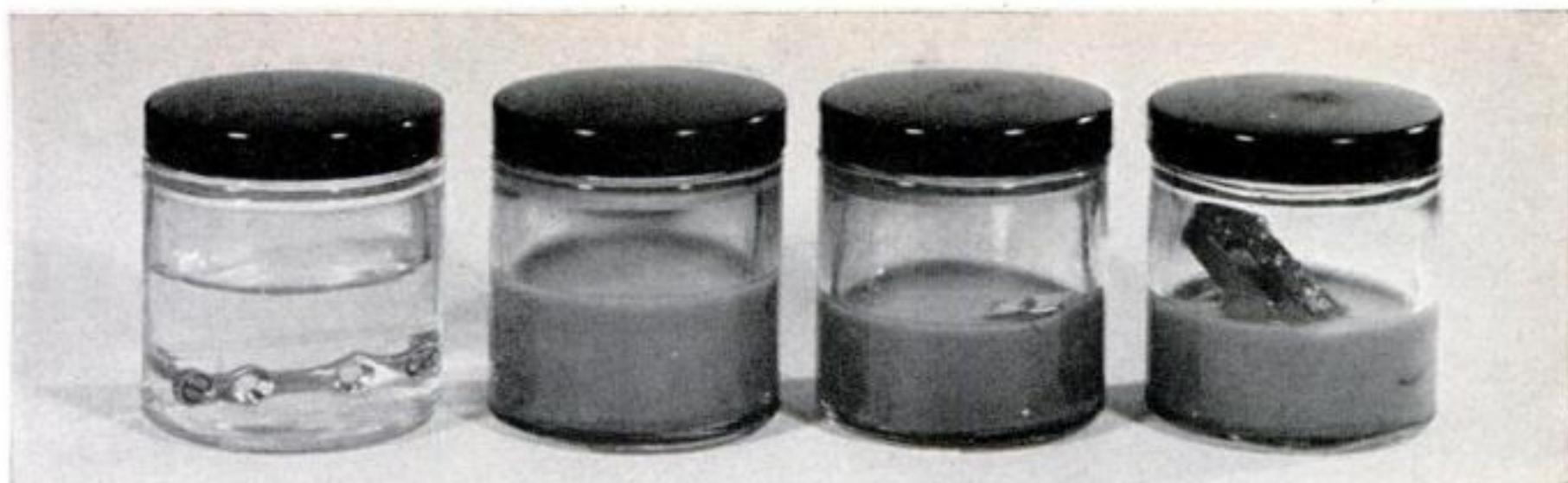
NEW ALLOY PERMITS AMAZING FEATS OF SURGICAL CARPENTRY

LIFESAVING feats of surgery, hitherto impossible, are being achieved with the aid of a remarkable new alloy. It provides surgeons, for the first time in medical history, with a metal that can be implanted permanently in the human body. Inert, non-corrosive, non-irritating, lightweight, and strong, this alloy, known as Vitallium, is producing revolutionary surgical accomplishments.

Patients bedridden for years with arthritic hips can walk



In the upper picture, a finished hip cap, left, contrasted with a rough one fresh from the mold. For preparing the caps, a wax pattern is placed in a container and covered with a special molding material as shown above. Heating removes the wax pattern, leaving the mold for the alloy



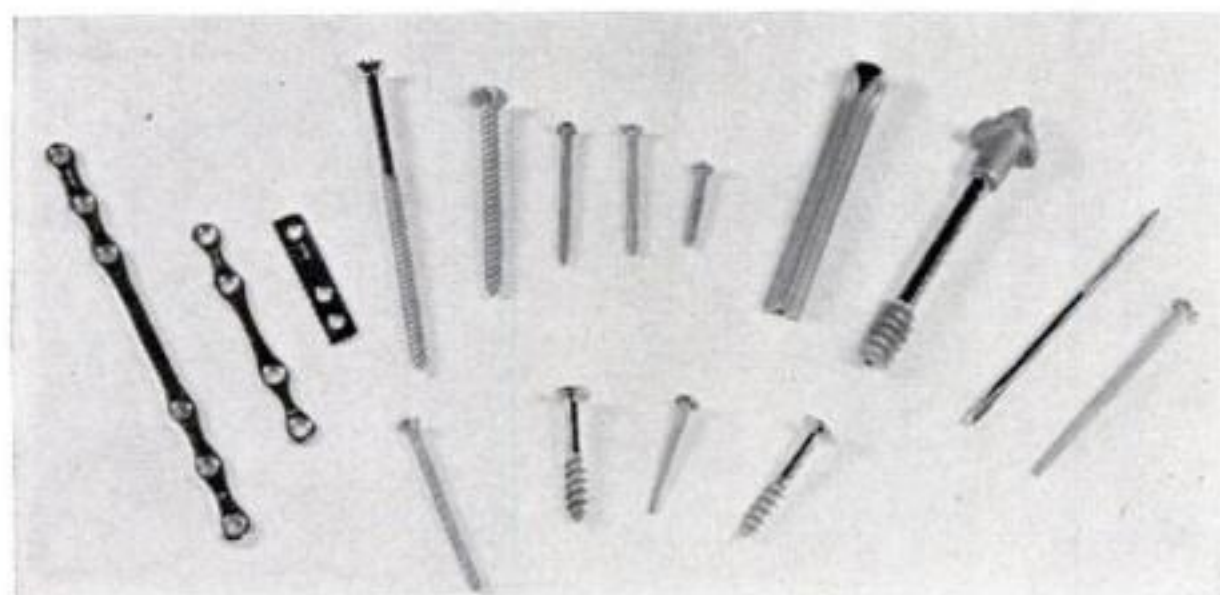
Vitallium body hardware, in the jar at left, is uncorroded after a week in saline solution. For contrast, the other jars show effect on vanadium steel, chromium plate, and stainless steel nickel-plated

again when caps of the metal are placed in the hip joints. Fingers stiff with arthritis have been made flexible by a similar insertion of Vitallium caps in the affected joints. Stoppage of the bile duct, formerly almost always fatal, is being cured by means of tiny tubes of the new alloy.

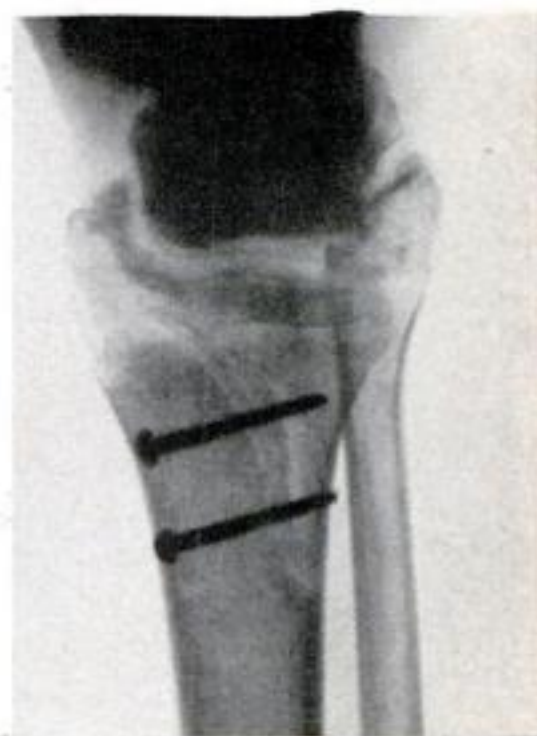
Screws, nails, and plates, employed in surgical carpentry and the repair of fractures, can now be left in place, eliminating the necessity of a second operation for their

removal. The United States Government recently placed orders for more than 150,000 Vitallium fracture plates and screws. Artificial teeth can be implanted in jaws by means of screws. So non-irritating is Vitallium that bone will grow around it.

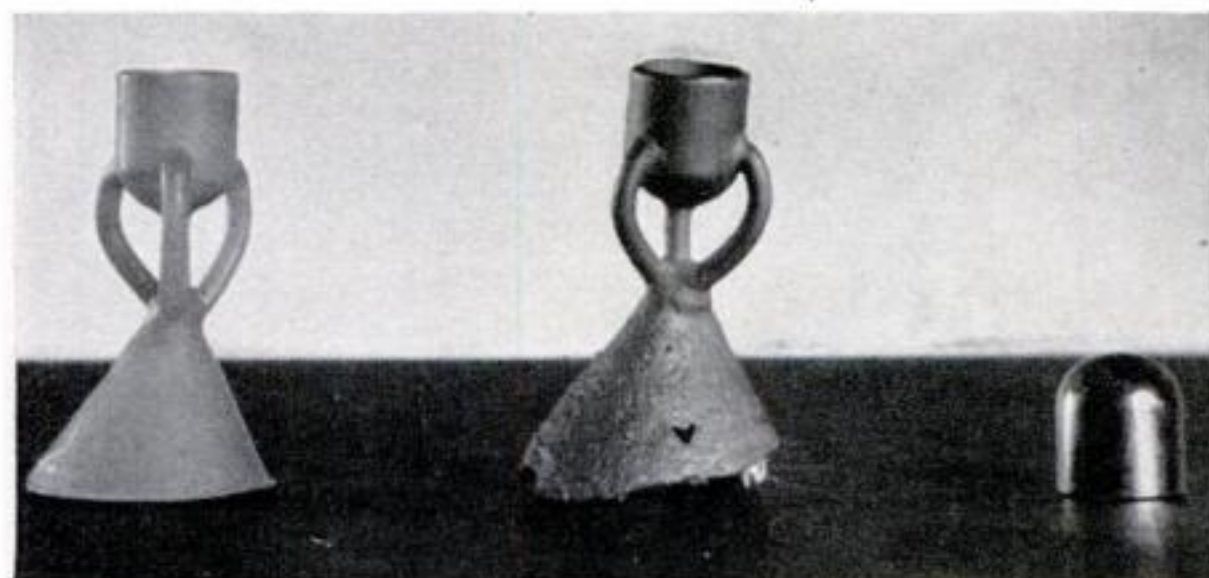
The main constituents of the patented alloy, which is the product of years of intensive research by two American experimenters, R. W. Erdle and C. H. Prange, are cobalt, chromium, and molybdenum.



PLATES, NAILS, AND SCREWS of the new alloy for use in surgery. The X-ray photograph at right shows how screws are driven into a fractured bone. The metal makes their removal unnecessary



FINGER-JOINT CAPS like the one in the X-ray were developed by Dr. M. S. Burman to loosen joints stiffened by arthritis. Below, left to right, are wax pattern, rough casting, and finished job



Heated Insulators

Safeguard Radio-Range Beacons

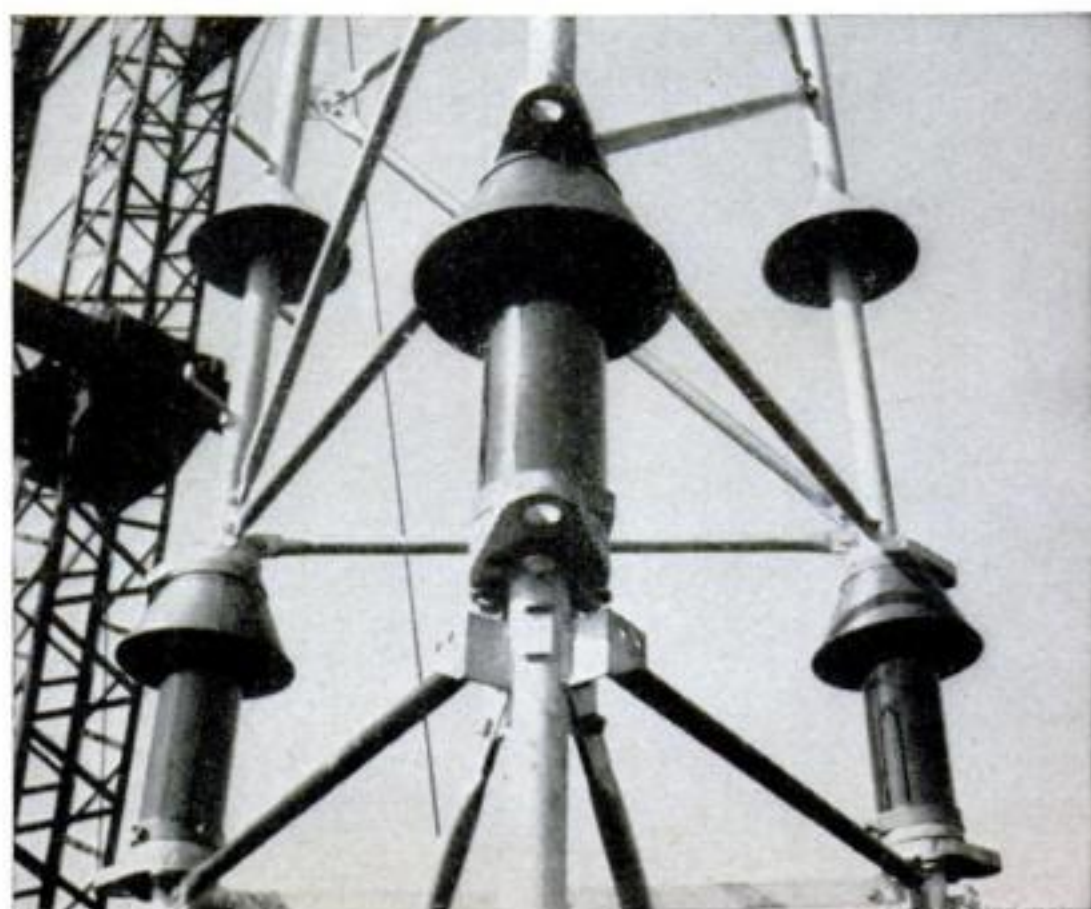
STRETCHING like a safety chain along Canada's northernmost borders, radio range stations made possible by a new, heated tower insulator are being built to help protect North America from invasion. The stations, each having four triangular towers, will be spaced about 250 miles apart, and will guide commercial and military aircraft through territory that includes the frozen arctic. They will make it possible for fighter planes to speed unerringly to meet an invader.

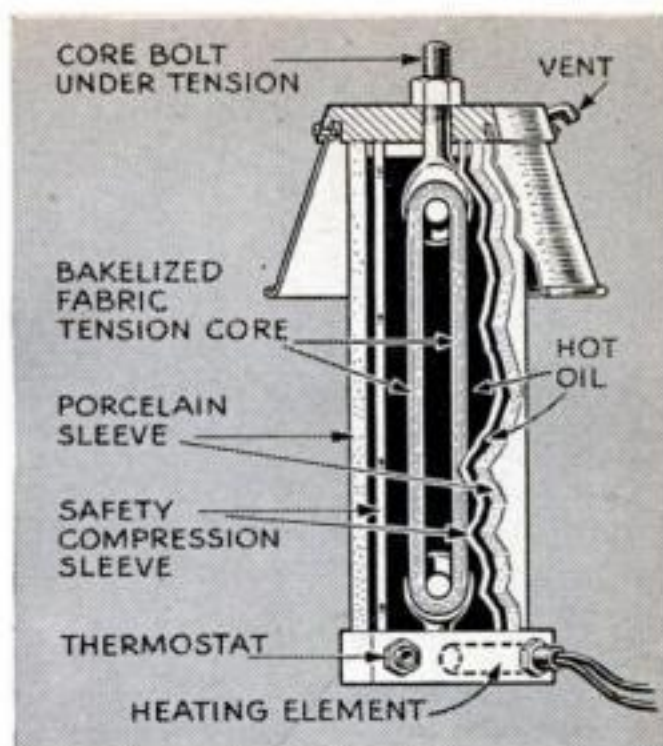
A radio tower is separated electrically from the earth by insulators near its base. Porcelain is the most satisfactory insulator material yet discovered, but it is easily broken. Conventional insulators are sometimes so fragile that a boy with a hammer or a .22 caliber rifle could send a tower tumbling to the ground simply by destroying one of the porcelain sections.

Arthur O. Austin, of Barberton, Ohio, an authority on transmission lines, insulation, high-frequency currents, and radio broadcasting equipment, has found a way of combatting this fragility and at the same time improving the uniformity and strength of a station's signal. He does this with an oil-filled, electrically heated porcelain insulator he invented.

This insulator has a porcelain compression tube, and inside it a non-shattering bakelite safety sleeve which supports the tower if the porcelain is

Its steel network reaching up 805 feet into the air and tapering from a base 40 feet square, this giant antenna at Station KHQ, Spokane, in which have been installed self-drying insulators, produces better coverage than with its original equipment. Below, insulators in place in a Canadian radio-range tower



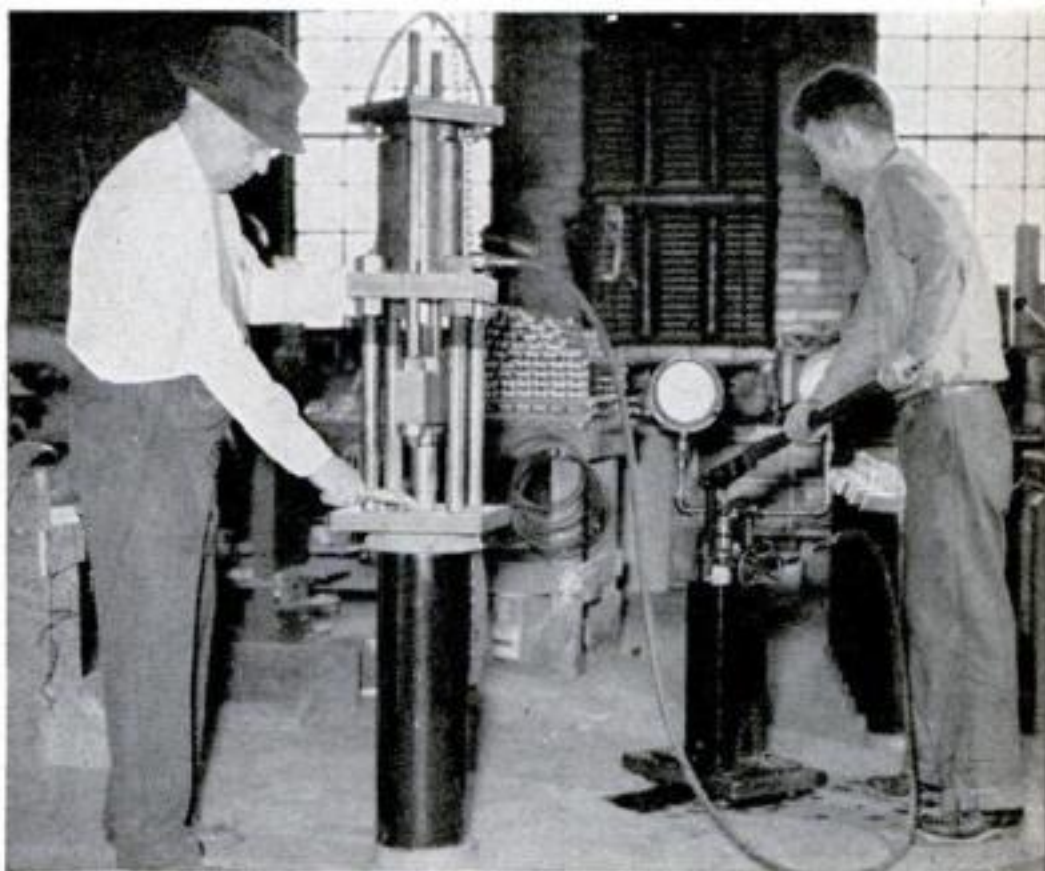


Arthur O. Austin, left, shows stages in assembling his insulator. In the photo, left to right, a tension bolt is adjusted in a tension link; next a safety sleeve is slipped on; then the porcelain tube is put on; finally, a completed insulator with rain shield

broken. Inside the sleeve is a bakelized-fabric tension link which connects bolts that pass through metal end hoods. This bakelite link pulls the caps against the porcelain with a force of about 17 tons, which strengthens the compression tube because porcelain is strongest when compressed. The insulator is filled with oil to prevent electrical discharges inside the tube. It also transfers heat to the porcelain from a 120-watt, 230-volt resistance unit in the base. One insulator of each set has a thermostat that keeps the oil temperature uniform and keeps the temperature of the insulator surface above the dew point, so moisture films will not form during fog or rising temperature and cause leakage of costly radio-frequency energy or alter the station beam. Electrical discharges over a moist surface are very erratic and unpredictable.

Rapid changes in radio beams guiding airplanes are often traceable to fog-drenched insulators, and such sudden beam shifting may cause a pilot to lose his course and crack up his ship.

In the center photo, Austin and a helper pre-load an insulator with a hydraulic ram that compresses the porcelain with a force of 50,000 pounds, increasing its strength. At bottom, workmen installing the insulators in a Canadian range tower

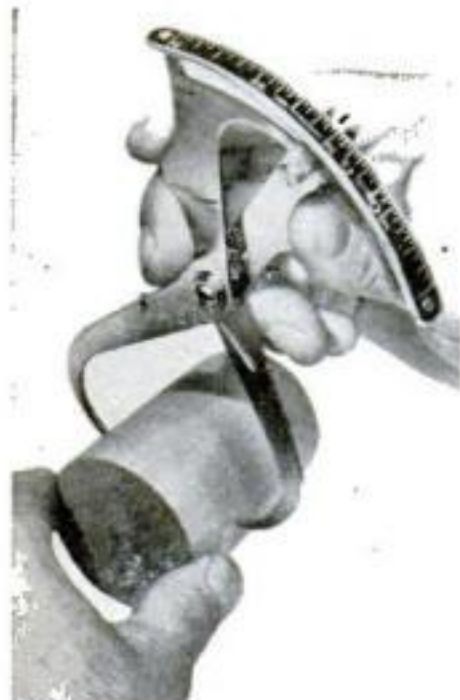


New Tools

A VIBRATING TOOL which makes 7,200 strokes a minute, with strokes adjustable up to $\frac{1}{8}$ inch, is used for engraving, cutting, hammering, or carving on metal, wood, linoleum, sheet rubber, sheet cork, glass, ceramics, and most other materials. A ball grip permits easy handling and accurate control. Accessories include fine and coarse needles for engraving, tungsten-tipped needles for glass and ceramics, knife blades, hammer tips, special cutters, and a foot gauge for controlling the depth of the cut. The tool remains cool in continuous operation.



MIDGET TOOLS are often needed by repair men for use on compactly designed, streamlined machines, into which bulky tools will not fit. Tools which resemble toys but which are strong enough for most work have been designed to meet this problem. Miniature pliers, hammers, sockets and attachments, wrenches, punches, chisels, pry bars, and spanners are now available. Among them is the world's smallest reversible ratchet. These tools are especially adapted to ignition, carburetor, radio, and refrigeration work, and other jobs in which it is necessary to slip instruments into confined spaces.



A DIRECT-READING CALIPER of four-inch size has been designed for home craftsmen and others who benefit by easier caliper reading. The scale, graduated in thirty-seconds, is directly in front of the user, and the markings are bright on a black background.

A SELF-PUNCHING center punch that supplies its own kick has been placed on the market. The hardened point is put on the spot to be marked, and the handle is pushed until a snap drives the point into the work.



Portable Cableway



An Army vehicle crosses a river in a test of the military cableway invented by Lt. Col. R. B. Lord of the Corps of Engineers



Rope slings under the wheels suspend a truck from the trolley, which is pulled along the 1½-inch steel cable by a lead line

A truck and trailer carry a complete mobile-cableway unit along roads to the site for a crossing. Boats are not regular equipment



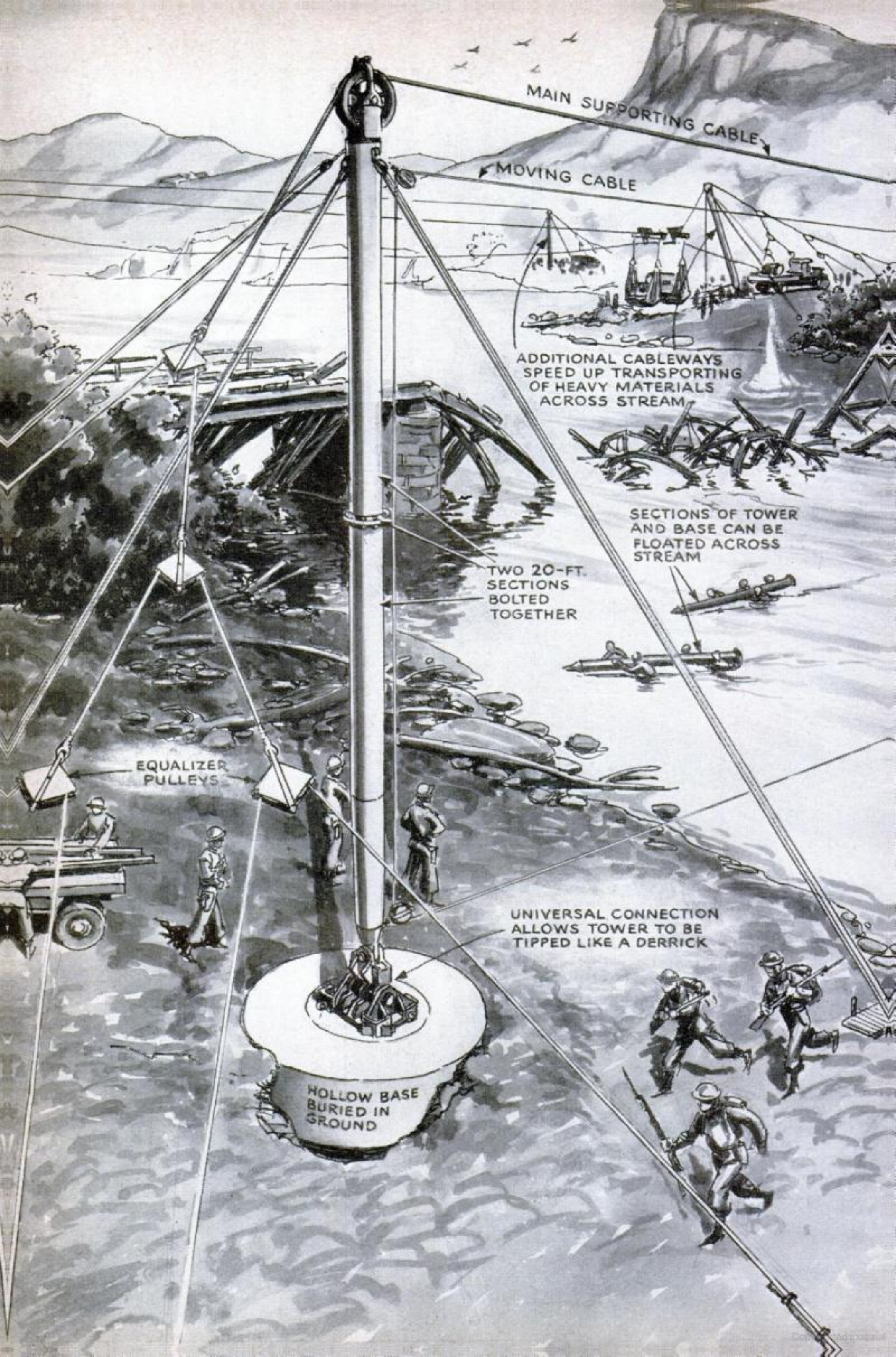
BRIDGES STREAMS TO CARRY ARMY TANKS AND TRUCKS

SWIFTER transportation of U.S. Army trucks and tanks across rivers and ravines is made possible by a compact portable military cableway invented by Lt. Col. R. B. Lord. In three hours, 13 skilled men, with the help of 40 unskilled ones, can erect the 14-ton cableway and have loads up to 13 tons riding across its 1½-inch steel cable at the rate of one every four minutes.

The breaking strength of this 750-foot cable is 240,000 pounds. The trucks, supported by it, cross the stream or gorge at a speed of 15 miles an hour. By throwing a series of such cableways across a river at intervals, a tremendous amount of material can be transported across without causing the bottlenecks created by ponton bridges, in which piled-up troops and material offer a tempting target to enemy artillery and bombing planes.

A truck and trailer are all that is required to transport the complete cableway along roads to the scene of operations. The 40-foot steel towers are constructed in 20-foot sections to facilitate transportation. Internal air compartments in these towers, and in the bases on which they rest, permit them to be floated across streams for erection on the opposite banks. By placing two cableways together and using them as a unit, loads up to 27 tons can be carried. The cost of a complete cableway is only about \$4,000.

Flood conditions, shallow



MAIN SUPPORTING CABLE

MOVING CABLE

ADDITIONAL CABLEWAYS
SPEED UP TRANSPORTING
OF HEAVY MATERIALS
ACROSS STREAM

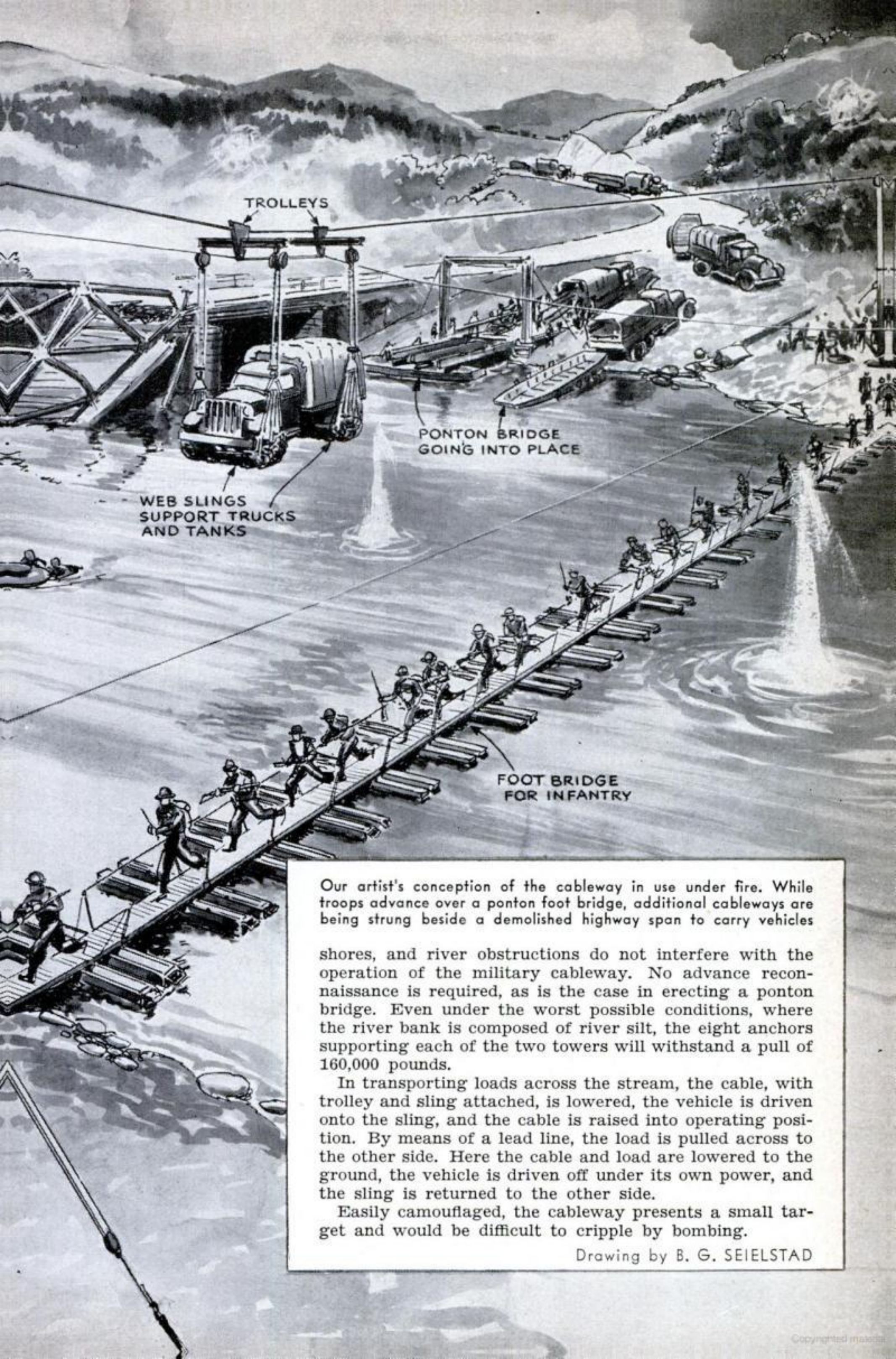
SECTIONS OF TOWER
AND BASE CAN BE
FLOATED ACROSS
STREAM

TWO 20-FT.
SECTIONS
BOLTED
TOGETHER

EQUALIZER
PULLEYS

UNIVERSAL CONNECTION
ALLOWS TOWER TO BE
TIPPED LIKE A DERRICK

HOLLOW BASE
BURIED IN
GROUND



TROLLEYS

WEB SLINGS
SUPPORT TRUCKS
AND TANKS

PONTON BRIDGE
GOING INTO PLACE

FOOT BRIDGE
FOR INFANTRY

Our artist's conception of the cableway in use under fire. While troops advance over a ponton foot bridge, additional cableways are being strung beside a demolished highway span to carry vehicles

shores, and river obstructions do not interfere with the operation of the military cableway. No advance reconnaissance is required, as is the case in erecting a ponton bridge. Even under the worst possible conditions, where the river bank is composed of river silt, the eight anchors supporting each of the two towers will withstand a pull of 160,000 pounds.

In transporting loads across the stream, the cable, with trolley and sling attached, is lowered, the vehicle is driven onto the sling, and the cable is raised into operating position. By means of a lead line, the load is pulled across to the other side. Here the cable and load are lowered to the ground, the vehicle is driven off under its own power, and the sling is returned to the other side.

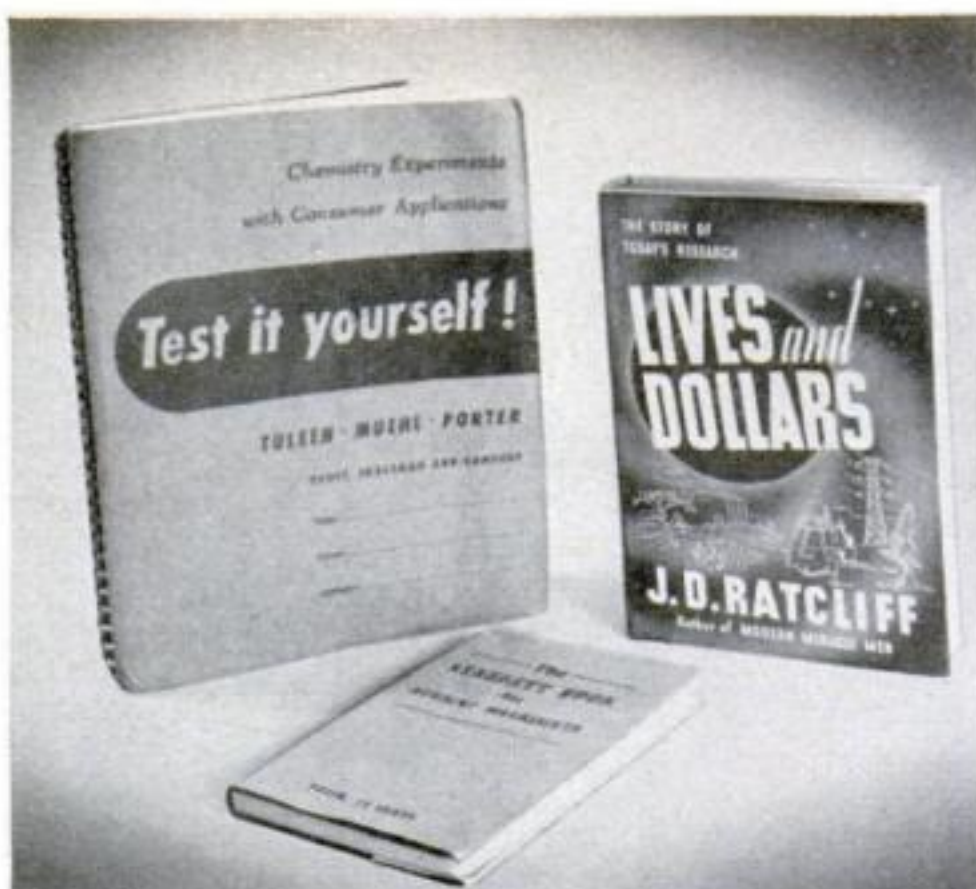
Easily camouflaged, the cableway presents a small target and would be difficult to cripple by bombing.

Drawing by B. G. SEIELSTAD

Book Review

HOW CAN YOU TELL if food has been adulterated? Judge the quality of paint? Determine the wearing ability of linen and cotton? Test fuel oils? Remove stains? Neutralize acid soil? Dozens of practical questions like these, with their answers, make "Test It Yourself!" (Scott, Foresman and Company) an attractive course in home chemistry. Instructions are given for 70 experiments, with condensed explanations of the chemical principles involved, although the manual is intended for use with a standard chemistry text for fuller understanding of the subject.

EXCITING RESEARCH ADVENTURES in medical and other fields—some that have made headlines, others that have not—are dramatized in "Lives and Dollars" (Dodd, Mead & Co.). In one of many striking incidents, hundreds



of thousands of CCC boys volunteer to give pneumonia vaccine a mass test.

PUBLISHED BY A LEADING TOOL FIRM (The L. S. Starrett Co.), "The Starrett Book for Student Machinists" is a pocket-size encyclopedia on shop methods. It explains developments as up-to-date as classifying metals by spark testing. There are 30 reference tables.

Cockpit Armor, Light and Tough, Protects Pilot from Bullets

SEEKING a lightweight armor of adequate strength to protect airplane pilots against the machine-gun fire of other planes, the Breeze Corporations, Inc., at Elizabeth, N. J., has developed a new method of production which appears to meet the mark. The essential details of the process are se-

cret, but the armor plate turned out is lighter than most other plate in use, and yet has unusual toughness and strength. In tests it has been found to repel bullets fired from .30 and .50 caliber machine guns at close range, which pierced heavy steel frames that supported it.

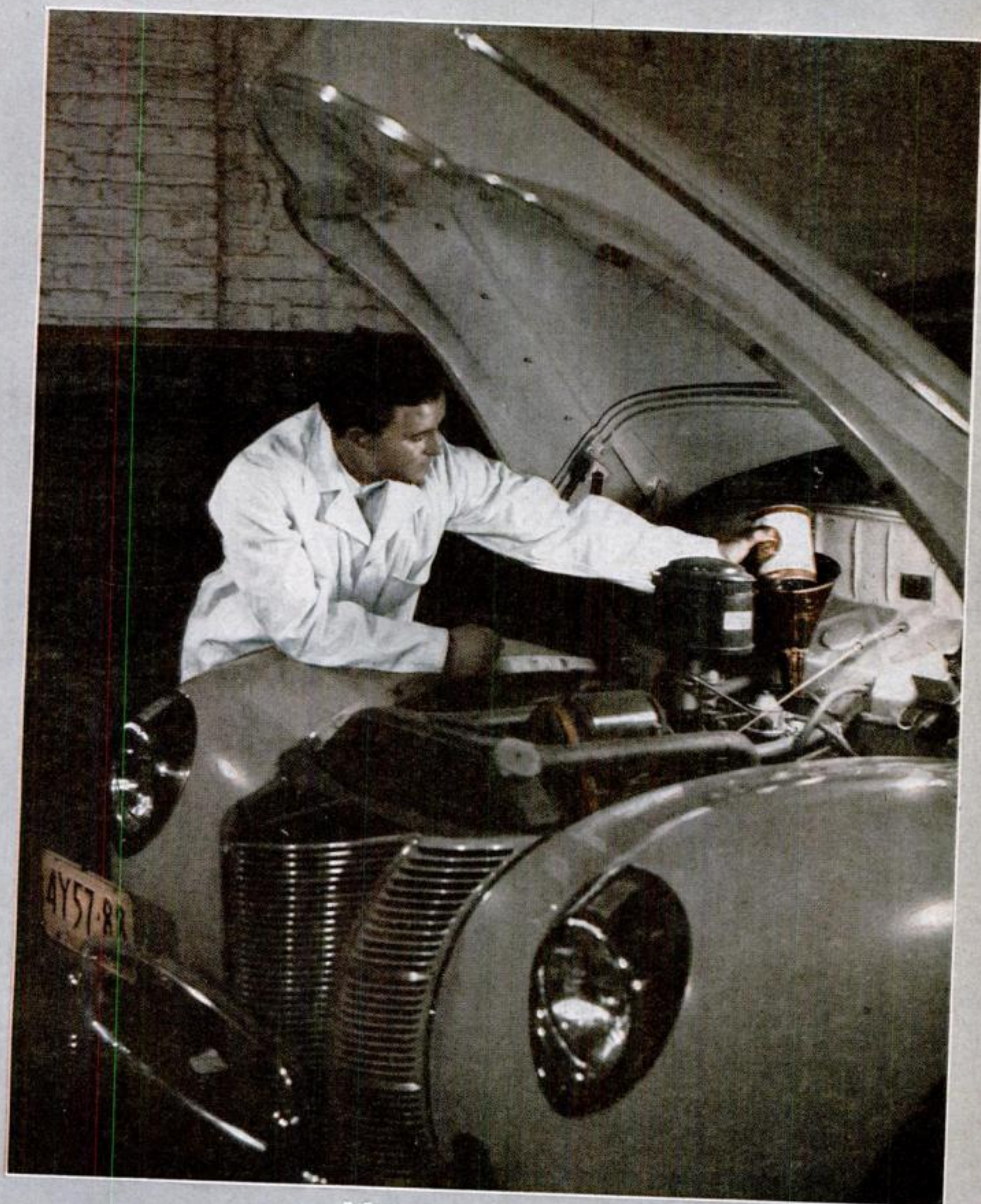


New armor plate, left, was dented but not pierced by .30 caliber machine-gun fire which, however, put holes in the heavy steel frame

The photo at the right illustrates how a pilot would be protected by the lightweight and very tough armor plate as he sat at the controls in the plane's cockpit



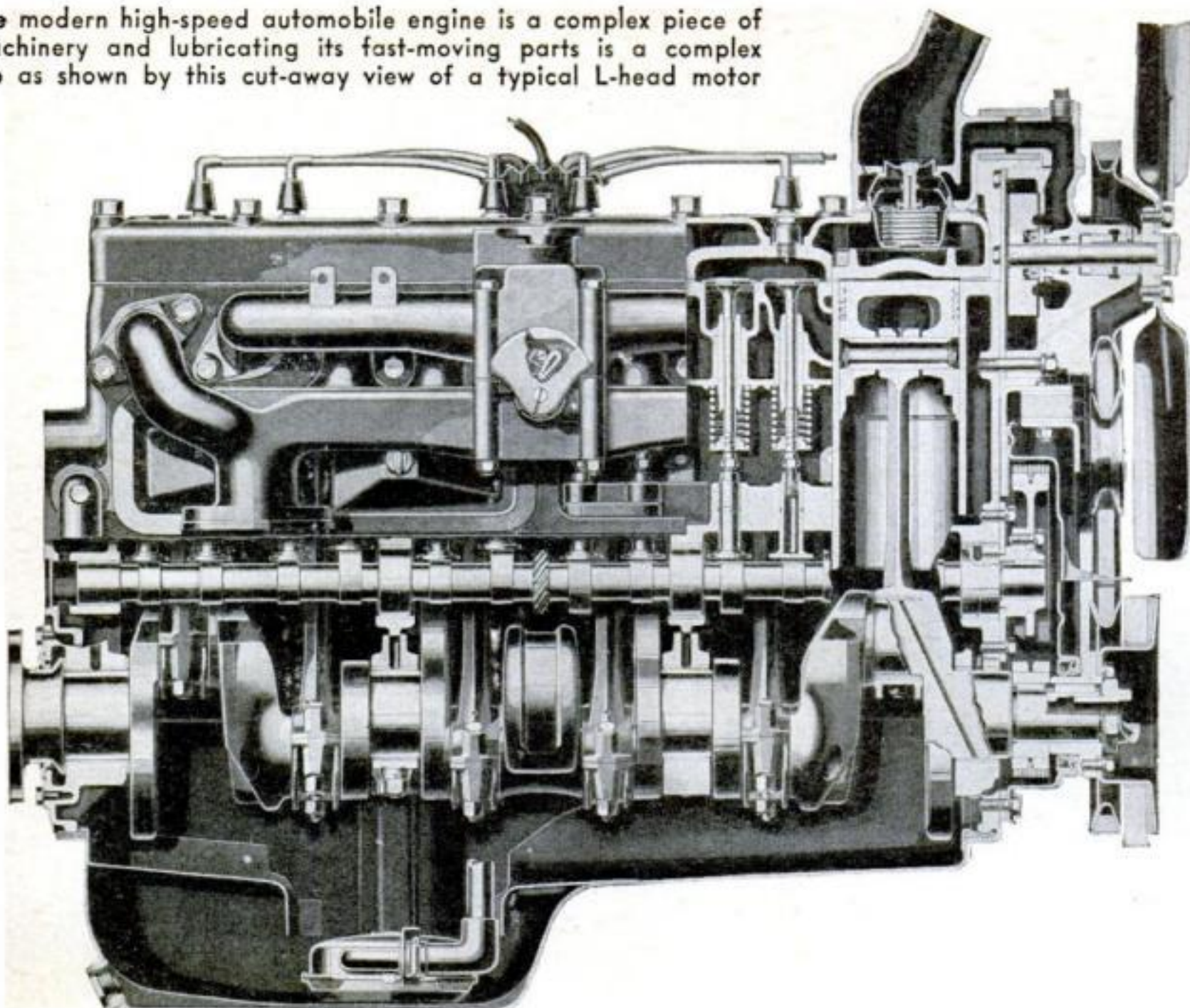
AUTOS



Your Car's Oil System

NEXT PAGE

The modern high-speed automobile engine is a complex piece of machinery and lubricating its fast-moving parts is a complex job as shown by this cut-away view of a typical L-head motor



Modern Lubrication Saves Your Engine

By SCHUYLER VAN DUYNE

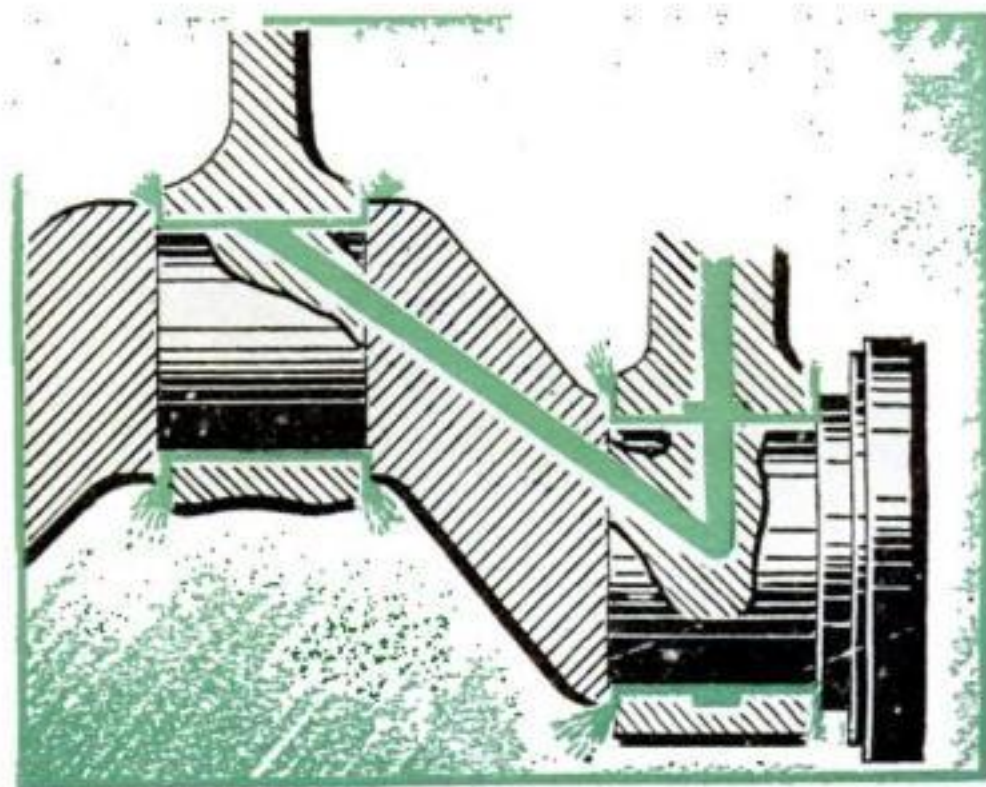
EVERY time you step on your car's self-starter, disaster is prevented by a layer of oil perhaps only a couple of molecules thick. If the layer were not where it should be—between the friction-bearing surfaces and the "journals" that revolve in them—your engine would soon "seize."

That is what engineers call it. To anyone who has heard it happen in a high-speed automobile engine, it sounds like an ocean liner's anchor chain dropping into an empty steel tank. It simply means that, because of lack of oil, journals and bearings have rubbed directly against each other, become intensely hot, melted, and finally fused together into a single metallic mass of junk!

You might ask why, if oil simply cools bearings, you cannot use plain water. The answer is that water is so thin and lacking

in "body" that it would quickly run out from between the metal surfaces. To quote the engineers again, oil has "viscosity," or body—the ability of its molecules to resist attempts to separate them from each other. And this ability is most powerful when oil is spread thin, as within a friction bearing.

To get oil into bearings, recover it, clean



How oil, in many car engines, flows under pressure through a main bearing and a hole drilled in the crankshaft to a connecting-rod bearing

it, and recirculate it, requires an ingenious mechanical circulation system not unlike that of the human body. There is in nearly every automobile engine, for example, an oil pump corresponding to the heart, an oil filter corresponding to the lungs, and a network of metered holes and pipes corresponding to the human blood vessels and arteries.

In several of the illustrations accompanying this article, well-known automobile engines are shown in phantom view to reveal their lubrication systems. You will see that each has an oil pan below it serving as a reservoir.

When your engine is running, oil is constantly being drawn from this reservoir by a powerful, gear-type pump that might be likened to two revolving doors set close together. As they turn, the outside edges pull oil through the fitted opening. The meshing edges effectively block oil from flowing back again.

On the lower end of the intake pipe there is usually a bell-shaped device, containing a fine-mesh screen, which dips well down into the oil pan. Oil drawn up by the pump is pushed through the pipes and drilled holes that honeycomb the engine. Since the speed of the pump changes the oil pressure, an escape valve that opens against a spring serves to maintain the pressure at nearly constant level.

The bearing surfaces lubricated by your engine oil are the crankshaft and the connecting-rod bearings, the camshaft bearings and cam surfaces, the piston pins, the cylinder walls, piston surfaces and piston rings, the valve lifters and stems, the valve push rods and rockers in valve-in-head engines, the timing gears or chain and sprockets, and at least part of the distributor shaft.

You may mark down as a rule that the oil goes under pressure to certain of these bearing surfaces. These are the crankshaft and camshaft main bearings, and the rocker arms of valve-in-head engines. On most cars, oil is piped through the whirling crankshaft, by means of drilled passages, to the connecting-rod bearings. Such oil enters the shaft at the main bearings under pressure. On Chevrolet engines, the con-

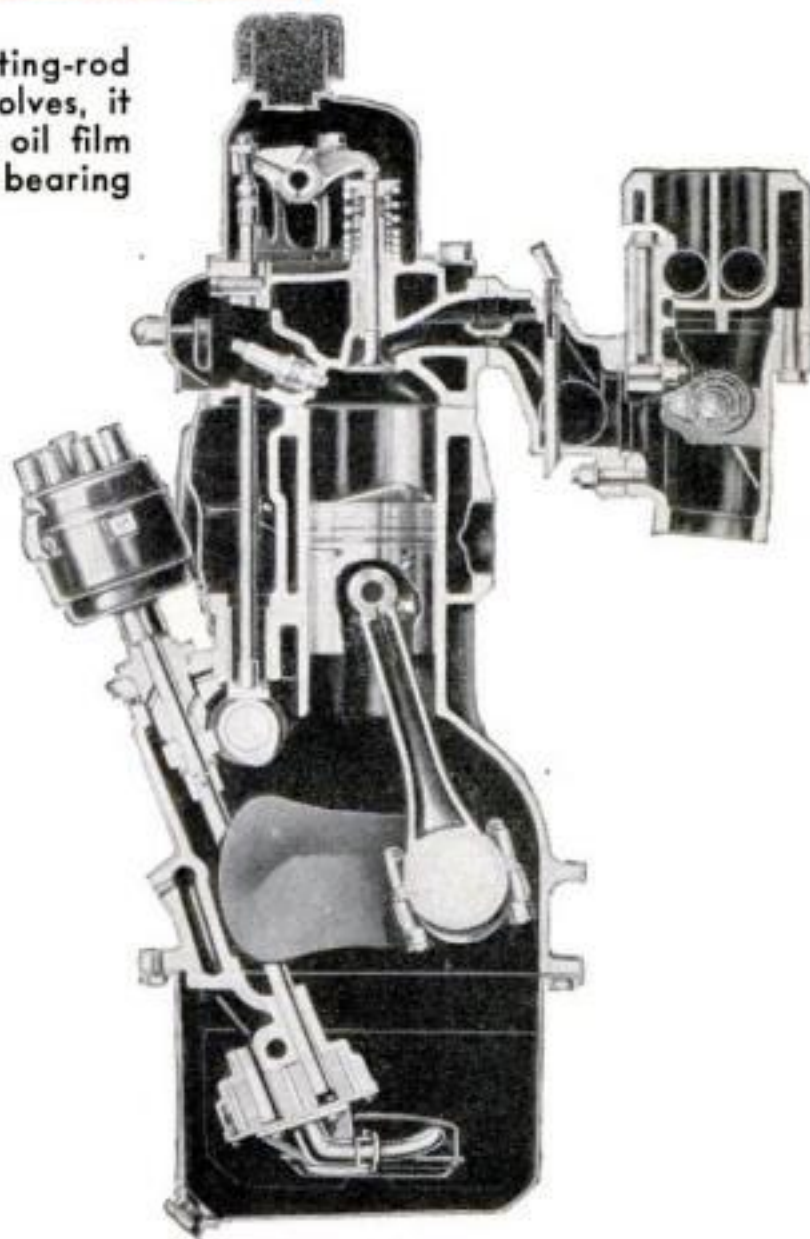
necting-rod bearings have downward-extending cups that intercept streams of oil with great force for their lubrication. On Pontiac engines, even the connecting rods are drilled from end to end. Oil from the lower bearings is thus carried up to the piston pins which, on other cars, are lubricated with spray thrown off by the crank throws. Such spray, on all cars, lubricates and helps to cool the pistons and piston rings, as well as the cylinder walls.

On engines of the L-head type, in which the entire valve mechanism is on one side, oil spray is largely depended upon to lubricate valve stems and guides, as well as the lifters that ride in tight-fitting sleeves above the cams. On valve-in-head engines, oil from the rocker-arm bearings flows down over the push rods and lifters.

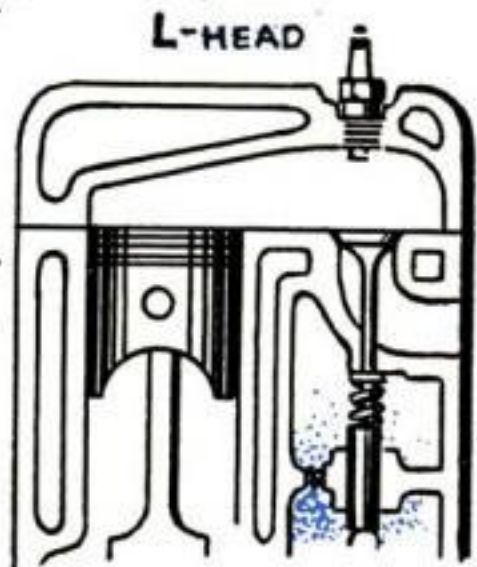
From its course through the engine, some of the oil is by-



Oil circulation in a connecting-rod bearing. As the shaft revolves, it pushes a crescent-shaped oil film around the surface of the bearing



Cross section of an overhead-valve motor showing important bearings which oil must reach. At bottom of crankcase, a common type of oil pump is seen



Valve Lubrication

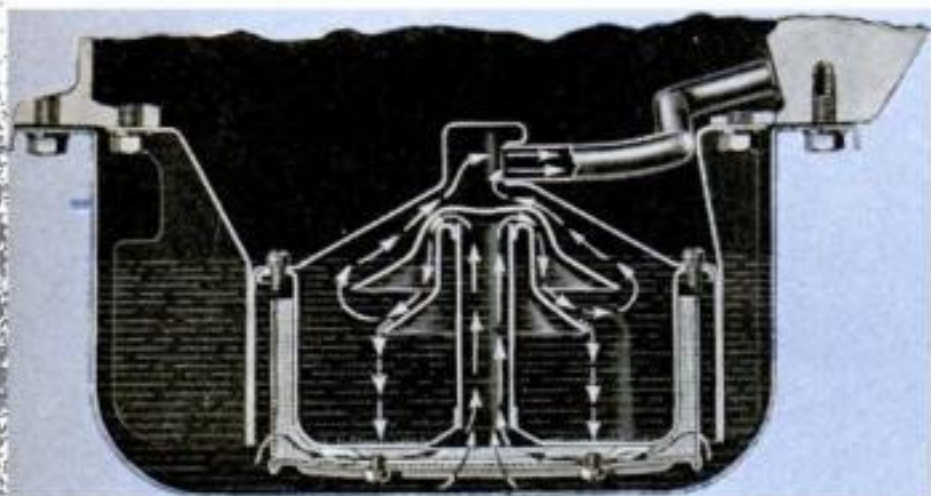
passed to the filter—standard equipment on most cars. Here it is forced through fine-mesh fabric packing which removes even the extremely fine particles of dirt, sludge, and metal that inevitably find their way inside your motor.

Today's cars would not last as they do without the important crankcase ventilation system built into all of them. In this, air enters the oil-filter cap, which contains a dust filter, and passes down into the crankcase. There, the clean air is whirled by the revolving crankshaft so that it "washes" the flying engine oil free of harmful moisture and acids that form during engine operation, and which ordinary oil filters would not remove. When it has done its work, the circulating air passes through a trap which returns any oil mist it may have picked up to the crankcase, and out through a pipe or "breather" tube.

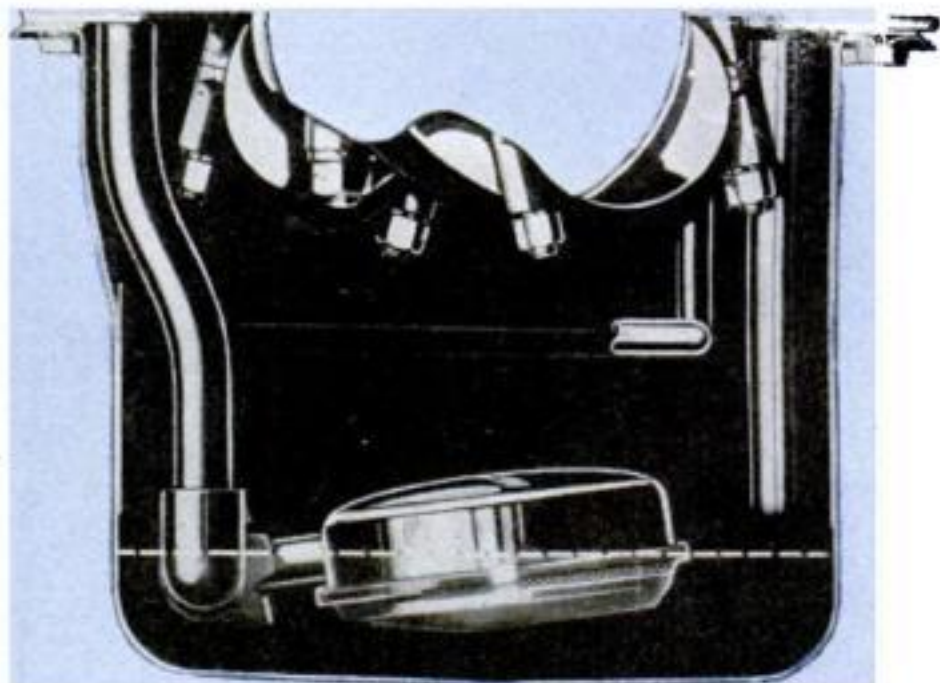
Sealing in your engine oil is one of the critical engineering problems which car builders have solved. In the "top" of your motor, piston rings prevent oil from passing into the combustion chamber, and valve guides, closely fitted to the stems, serve the same end. Where metal engine parts are joined, as the oil pan to the upper crankcase, and the timing-gear and valve covers to the cylinder block, cork or composition

Two ways of lubricating piston pins—by spray and by drilled connecting rods—are shown at left, top. Spray from all bearings helps to cool pistons and lubricate cylinder walls. Below, the oil system for overhead valves, in which oil is carried to the rocker arms, and for L-head engines, which utilize spray

TWO NEW BUILT-IN OIL-FILTERING DEVICES



BUILT-IN FILTER. Pontiac's arrangement of traps, filters, and baffles is designed to clean the oil before it enters the pump



FLOATING INTAKE on Chrysler cars takes oil from beneath surface yet not from pan bottom

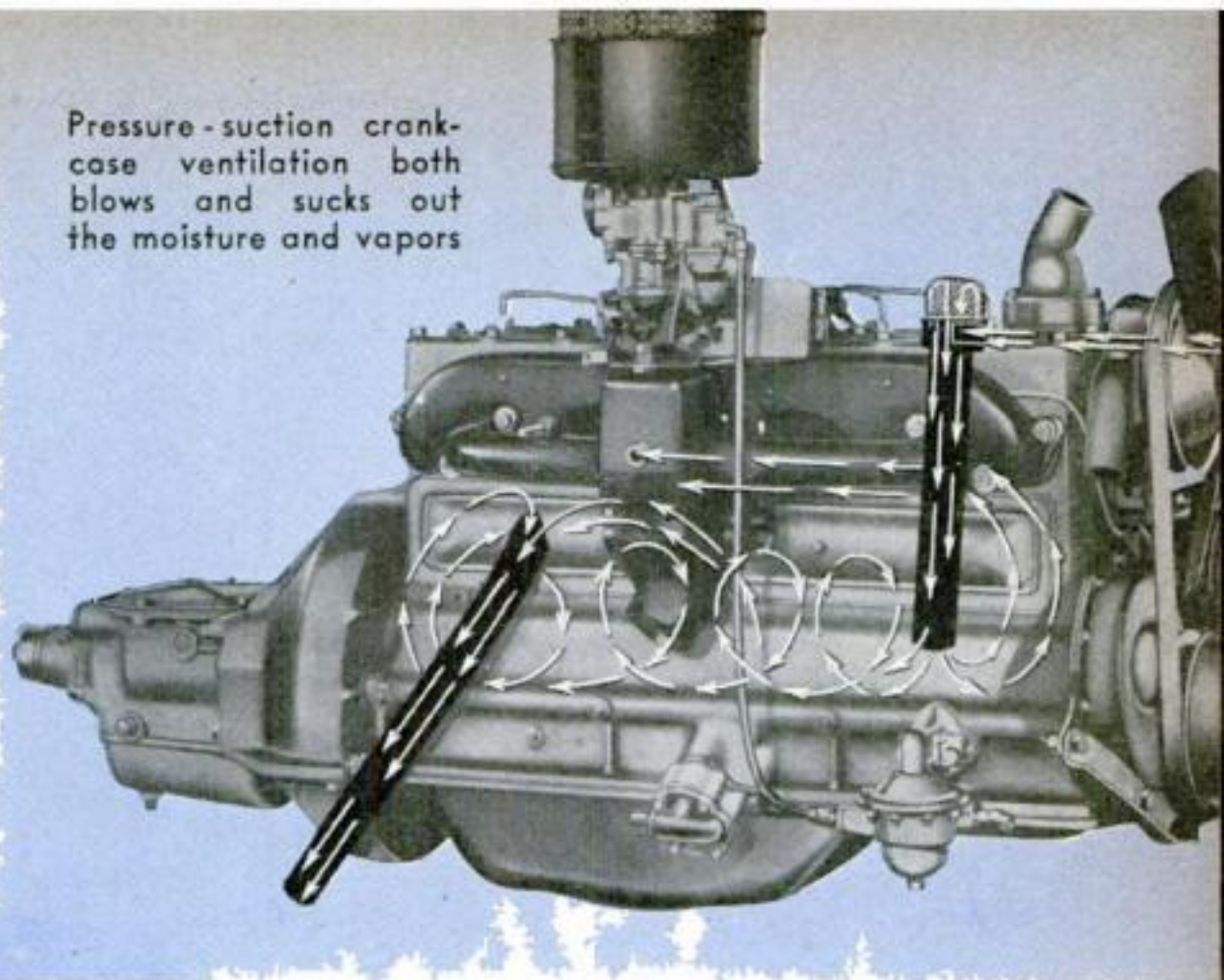
gaskets seal the cracks. And where crankshaft ends emerge from the engine, one of the most ingenious examples of leakproofing is found. Here, in addition to close-fitting seals that check seepage, a ridge of metal circles each end-bearing journal. Any oil passing the bearing is thrown by centrifugal force to the edge of the ridge and off into a channel. From the channel, an oil duct leads the wayward lubricant back into the crankcase.

On the outside of your engine there are few moving parts to be lubricated, but they are important ones. These are the water-pump shaft which on most cars also turns the fan, the upper section of some distributor shafts, and the bearings of your starter and generator. In addition, there are the carburetor control rods and their links.

Some of these are lubricated by hand with an oil can. On the water-pump and distributor shaft, grease fittings are the usual means of lubricating. Compared with internal engine bearings, the loads carried by most of these are light.

Some of them, and a few inside the engine, are permanently oiled, in Chrysler-built cars, with bearings that are actually made of a special oil-impregnated metal. Developed by Chrysler engineers, the material is also used in the moving parts of a specially designed oil pump which gives higher engine-oil pressure at low engine speeds.

Pressure-suction crank-case ventilation both blows and sucks out the moisture and vapors

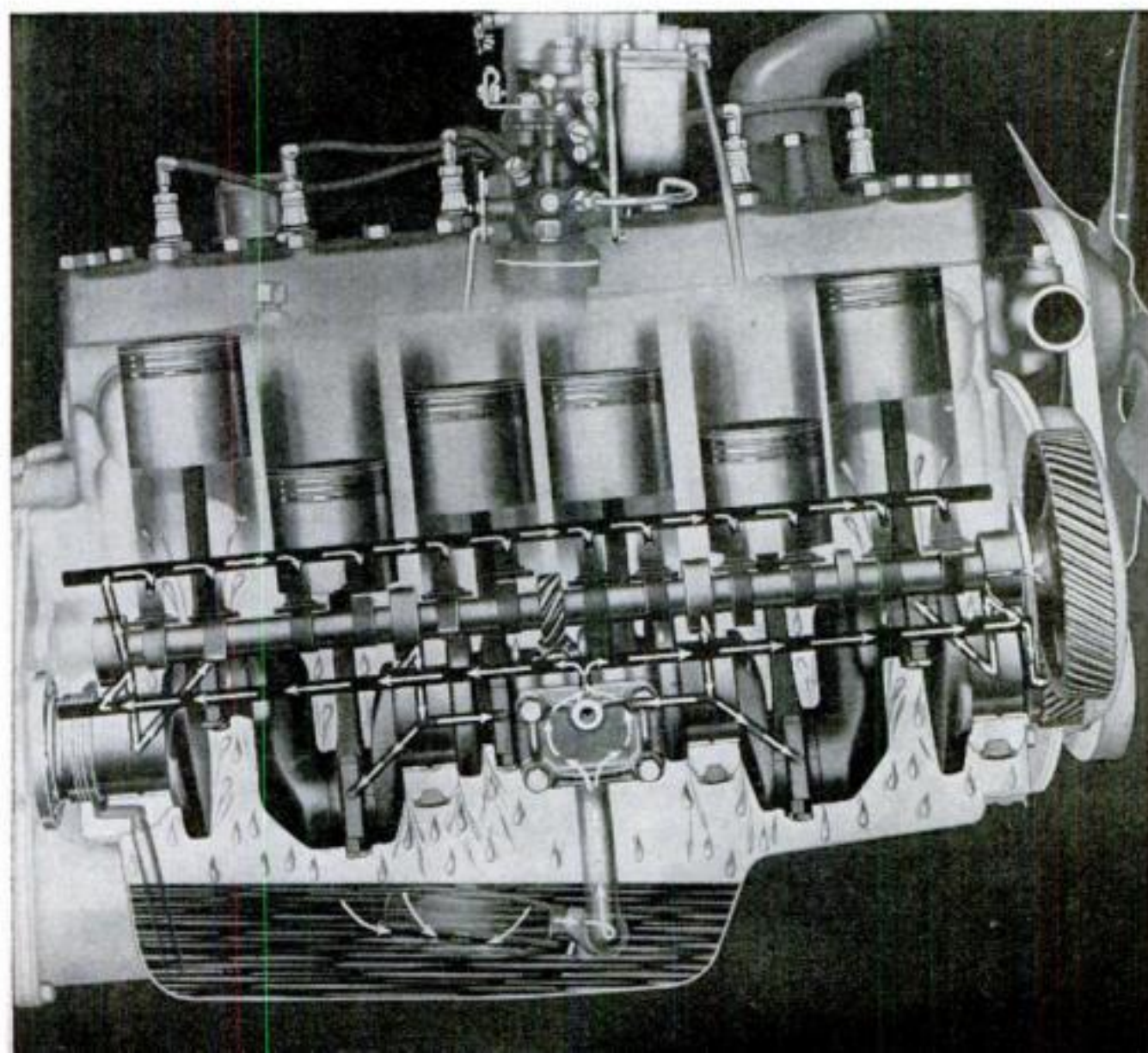


Automobile manufacturers have gone to great lengths to make engines lubricate themselves efficiently, but with your purchase of a car, the responsibility becomes yours. There is little left for you to do, however, besides keeping those many close-fitting bearings in your engine in good condition. For when they become loose, oil leaks from them too rapidly. Too much of it then reaches the top of your motor at about the time that piston rings and valve stems also begin to show wear, and oil escapes past the rings and valves to burn up in the combustion chamber. Your oil bills promptly skyrocket.

But you don't have to be an automotive engineer to keep bearings in good condition. Changing your oil, using the proper grade and quality oil, replacing the filter when necessary, and occasionally cleaning the oil-filler breather cap as your manufacturer recommends, will automatically do the best possible maintenance job for you by keeping oil clean and new. Dirt, chemicals, and other impurities then cannot attack and cause wear in the bearings.

And remember that good oil is as necessary as gas and water to your car's long life and efficiency.

Full-pressure lubrication. This phantom view of a six-cylinder engine shows the course of the oil from the intake through the pump to engine bearings



How To Save Gas

BY KEEPING your car tuned up, and by driving carefully so that you travel the maximum number of miles on each gallon of gas, you can put pennies in your pocket, contribute to national

defense, and be satisfied that your car is doing its best. This is particularly true in sections where a shortage of motor fuel exists. Below are a few hints on what to do and what not to do.

DO



STOP SLOWLY. Coast up to stop signs and traffic lights, letting your motor brake the car as much as possible. In addition to saving gas, this will save tires and brakes as well.



CHECK SPARK PLUGS frequently, as well as other parts of the ignition system, to see that they are clean and properly adjusted. A good spark is the life of any motor.



KEEP BRAKES properly adjusted. Dragging brakes make your engine work harder, consume more fuel. They are like hidden taxes — taking money away from you where you least suspect it.



INSPECT FUEL PUMP and lines for leaks. Seepage from loose joints will account for a lot of fuel over a period of time. Leaks that go unfixed are fire hazards as well as gas wasters.



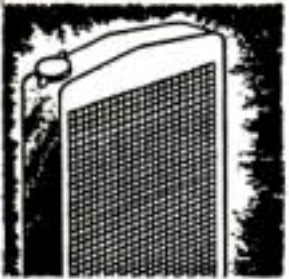
ADJUST YOUR CARBURETOR to get the proper ratio of gasoline and air. Too rich or too lean a mixture burns excessive gas. Avoid using the choke more than is necessary.



GREASE AND OIL chassis and engine in accordance with the maker's recommendations. Too heavy lubricants drag like cold molasses; too light ones allow friction and wear.



BUY GAS that is produced by reputable refineries, and you will have a better chance of getting good mileage than if you gamble with bootleg gas or an unknown product.



BE SURE the cooling system is working properly. An engine that runs too hot or too cold wastes gas and wears out faster than one that is kept at the proper temperature.

DON'T



DON'T SPEED. Gas mileage drops sharply as speed goes above 40 miles an hour. At 60 you are practically throwing gas away. Take your time and you'll get there on less gas.



PARKING IN THE SUN is wasteful because gasoline tends to evaporate rapidly when it is hot. Park your car in the shade and your gas won't vanish into thin air so fast.



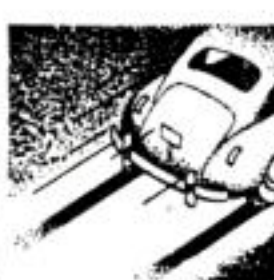
PUMPING the throttle feeds more gas into the engine than it can consume economically. Besides wasting gas, this practice is hard on running gear and causes needless tire wear.



DON'T FILL your tank to the brim. Bumps and turns may slop it out if the cap isn't tight. Attendants should avoid spilling, and some room should be left for expansion.



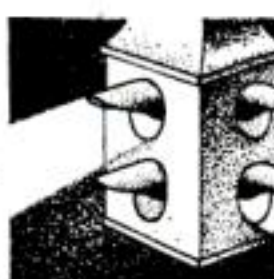
KEEP TIRE pressures up to the proper point. The car may ride better with soft tires, but 14 percent too little air will decrease your miles per gallon by 2½ percent.



AVOID QUICK STOPS. By anticipating traffic lights and other stopping points, you can get along on 50 percent less gas than you will use if you are a brake rider.



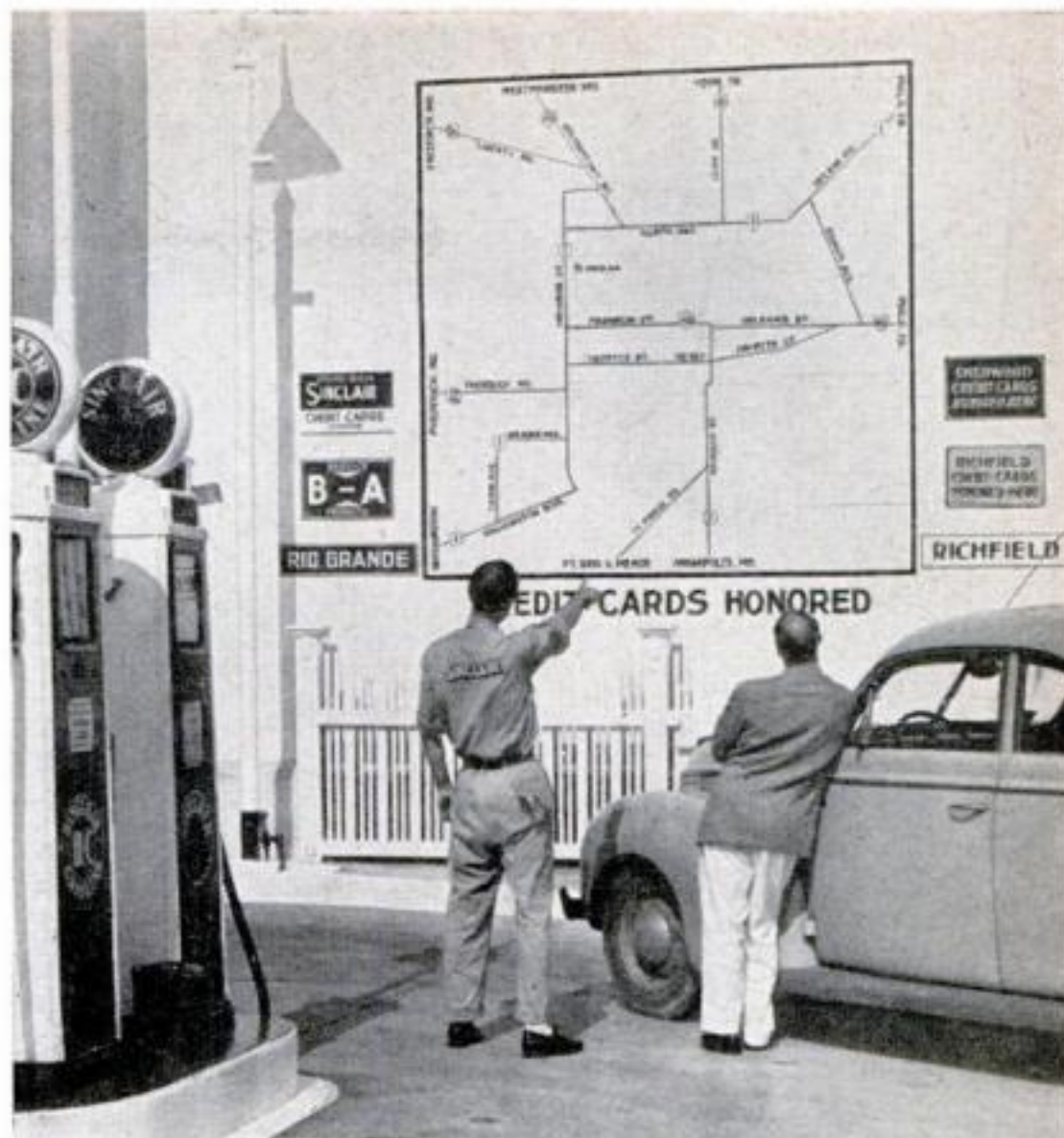
SHIFT INTO HIGH as soon as the car reaches a reasonable speed. Don't ride in second and don't "force" it in the lower speeds. Trying to overcome inertia in a hurry is expensive.



JACK-RABBIT starts when you get a green light are real gas wasters. They are hard on tires too. Let the car pick up slowly and both car and gasoline will last longer.

Auto Ideas

PAINTED ON THE WALL of a filling station in Baltimore, Md., is the large-scale map of the city shown at the right. Located at Baker and Monroe streets, the station is on U.S. Route 1, a main north-and-south highway through the Eastern States. After answering what seemed millions of questions from motorists who wanted to know how to get places, the station operator decided he could save time and still give his customers directions if he didn't have to pull out a map every time. The one on the wall, showing through routes and principal streets, was his method of solving the problem.



WINDSHIELDS and other fixed panes of glass in automobiles are apt to develop leaks around the edges after they have been exposed to sun, rain, sleet, and snow, no matter how well they were set when the car was new. Frequently leaks are not bad enough to warrant removing the glass to fix them. For such cases, a sealer has been developed and is sold in a tube. It dries rapidly, forming a transparent bead along the edge of the glass. It will stick to wood, glass, metal, or plastic. Tubes of the sealer are available in one-ounce and 5 1/4-ounce sizes.



As a check on gasoline waste, the tester above is attached to the exhaust pipe with the motor running for a reading on the indicator at right

GAS SAVER. With everybody seeking ways to make gasoline go farther, the portable exhaust-gas tester at the left should prove useful. Similar to carburetor-mixture indicators on plane engines, it can be used on the road or in the shop. A hose on the tester is inserted in the exhaust pipe, and a pointer moving across the scale below shows whether or not the carburetor is set for most efficient operation, and if it is not, what should be done to correct it. Bus companies and other fleet operators are using the tester.



We'd like
about 200
traffic
fatalities
next year



Okay,
you're
the one
to
decide

Are you guilty of these —

12 COMMON DRIVING FAULTS



Let's have
new models
in
people

- 1 FAILURE TO SIGNAL.** Sudden changes in speed and direction don't give the other fellow much of a chance to miss you

I didn't mean
to have an
accident

Trouble
with you,
you didn't
mean
NOT
to



- 2 POOR JUDGMENT.** Trailing another car too closely or passing on a hill or curve are invitations to trouble



He who yields
the right of way
may live to drive
another day

- 3 DISCOURTESY.** The road hog is a danger to himself as well as pedestrians and the other drivers on the road

Well,
I saved
5
minutes



- 4 IMPROPER TURNS** may save time, but they take their toll in smashed fenders, jagged nerves, and broken bones

Drunk in car-
gates ajar



- 5** ALCOHOL doesn't mix with cars, and the same goes for drowsiness, illness, and general nervousness

What's the hurry?
When we get there
we'll just
sit



- 7** DRIVING TOO FAST for road conditions. Traffic, road surface, weather, and visibility should control your speed



- 6** WEAVING IN TRAFFIC. Driving in the wrong lane. Swerving. A straight line is still the shortest distance between points



- 8** OVERCONFIDENCE in your ability to "stop on a dime," puts a big load on your car's tires and brakes

And how about these?



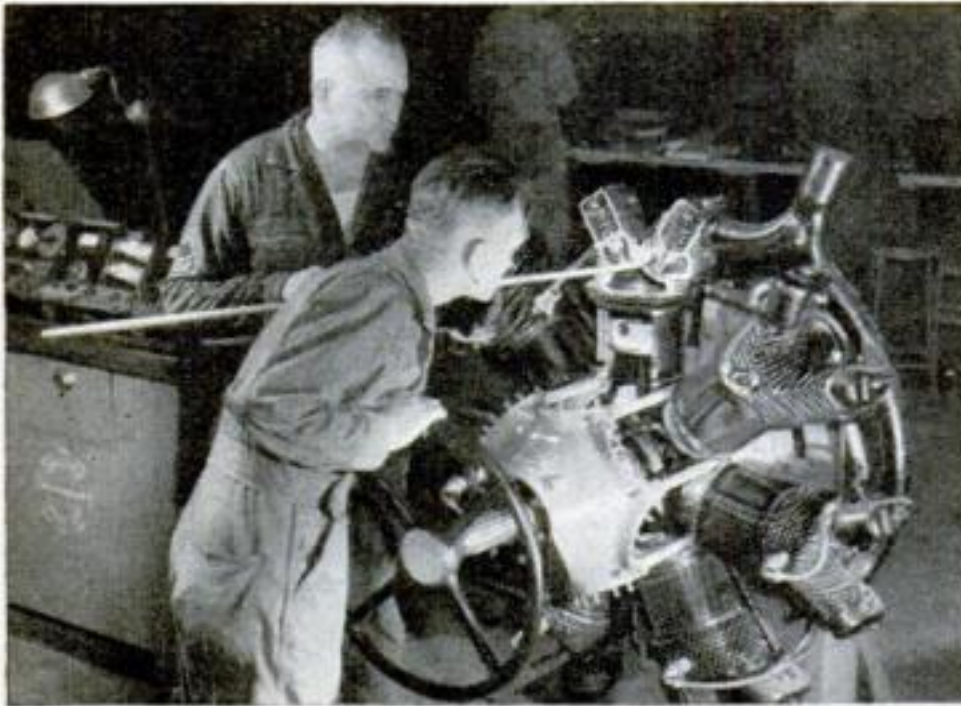
- 9** INATTENTION. Driving a car is a full-time job that leaves little time for rubber-necking.
- 10** POOR USE OF HEADLIGHTS. Failure to dim your lights when passing an oncoming car. Use of "brights" in city streets.
- 11** FAULTY CAR. Lack of proper equipment. Failure to have brakes, lights, tires, and motor checked periodically.
- 12** OVERUSE OF HORN. Don't substitute noise for skill. Use your foot on your brakes instead of your finger on the horn button.

To make your driving happier and safer, check your driving habits against these faults

Motorization Means More Mechanics...



A student mechanic at the Quartermaster Motor Transport School, Holabird Quartermaster Depot, Baltimore, Md., tries his hand at tightening a fan on an Army car



With a cut-away model of a radial gasoline engine, an instructor shows a rookie what makes it click. Visual instruction and demonstration lead the way to practical application in school shops

These boys are learning about hub assemblies. They take down and assemble various units such as engines, transmissions, differentials, fuel pumps, and distributors until they can almost do it with their eyes shut



IT TAKES more than gasoline and oil to keep the Army rolling these days. Mechanics are needed, hundreds and thousands of them. Not just ordinary mechanics, but men who have been trained in the intricacies of four-wheel drives, high-torque differentials, constant-velocity universal joints, and the thousand and one other special items that make the U. S. Army vehicles just about the best in the world.

To fill this need, the Army's Quartermaster Motor Transport School at the Holabird Quartermaster Depot, Baltimore, Md., along with other similar schools, has been expanded to many times the size it was a couple of years ago. Then it was turning out classes of 150 enlisted men every nine months, with small officers' classes in the spring and fall. Now, with new buildings and equipment, the enlisted students number more than 1,000, with a correspondingly increased number of officers, and classes are being graduated every month.

Some of these boys who are being trained to maintain the Army's more than 200,000 tanks, cars, trucks, and motorcycles were expert commercial mechanics before they signed up. Now they are learning how the Army does

...So the Army Enlarges Its Auto School

it. The others are lads with a flair for mechanics and a head for learning. All were picked by commanding officers of units of all branches of the service, from posts all over the U. S., some for training in the one-month basic course, others for one of the three-month specialist courses, and some for both.

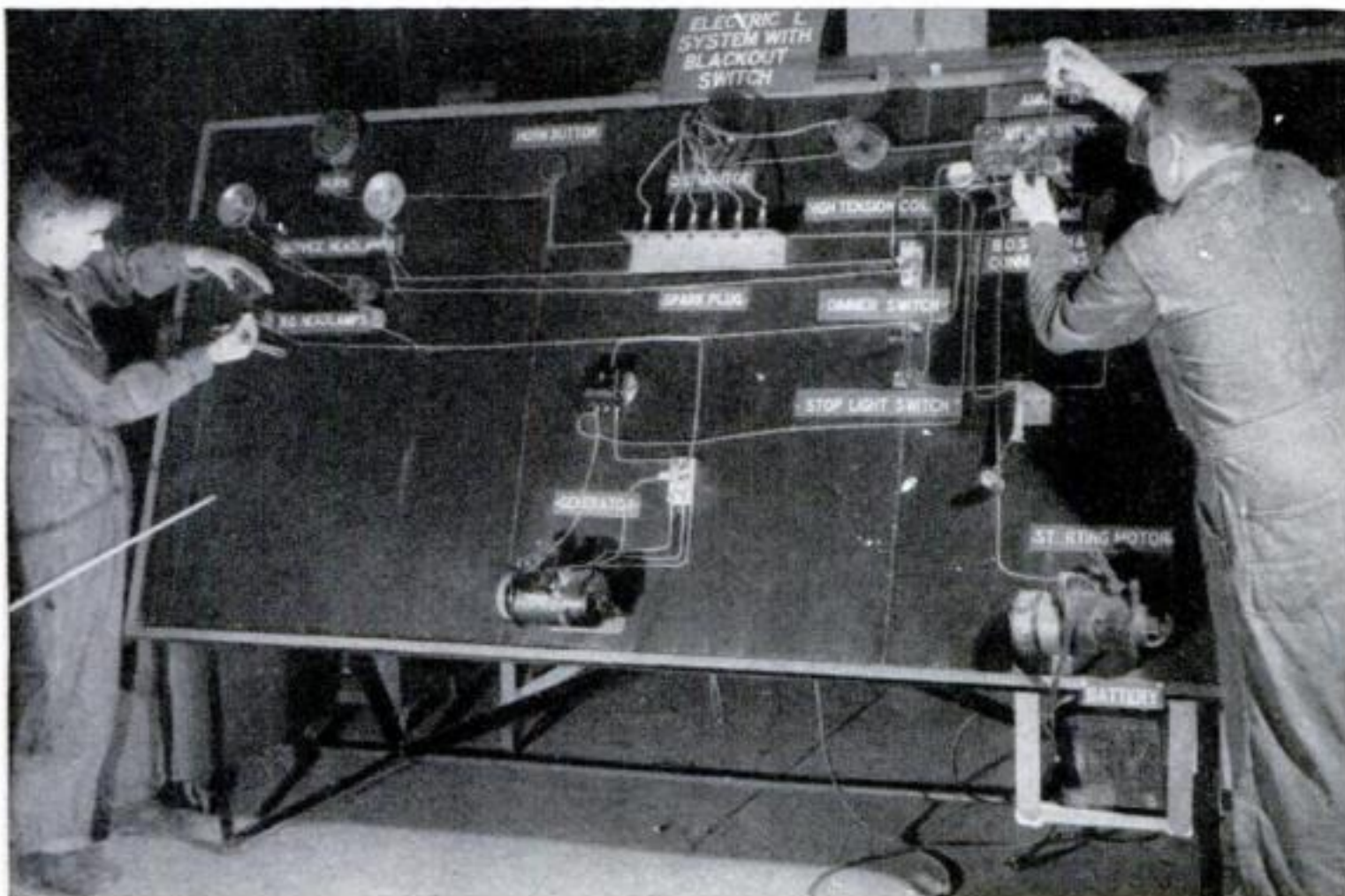
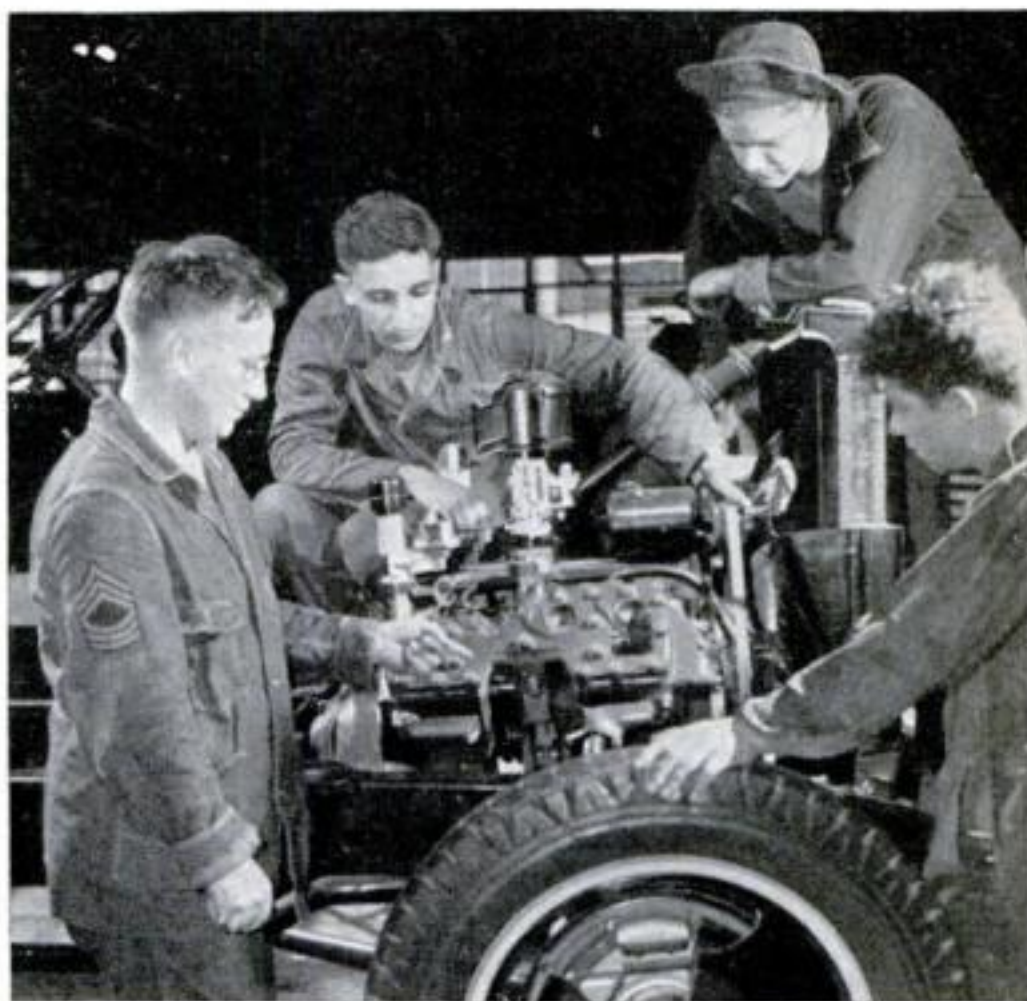
In the basic course they learn the principles of internal-combustion engines, gears, and suspension systems, so that they will be able to do simple maintenance work such as greasing, changing spark plugs, and making minor repairs.

The specialist courses cover many fields. They include such trades as welding, blacksmith work, sheet-metal and body repairing, upholstering, and machine-shop work.

The school works on a basic theory of explanation, demonstration, and application. Students start off with classroom work with civilian or Army instructors, with one instructor for every 20 students. With diagrams, movies, and lectures the instructors show what makes an automobile go, and what has to be done to keep it going. Then the students move into the

huge shops, where pieces of cars, trucks, and motorcycles are scattered all over the place. There the instructors point out and demonstrate the things discussed in the classrooms.

The third step is to have the students take down and assemble units such as engines, transmissions, differentials, fuel pumps, and distributors until they are

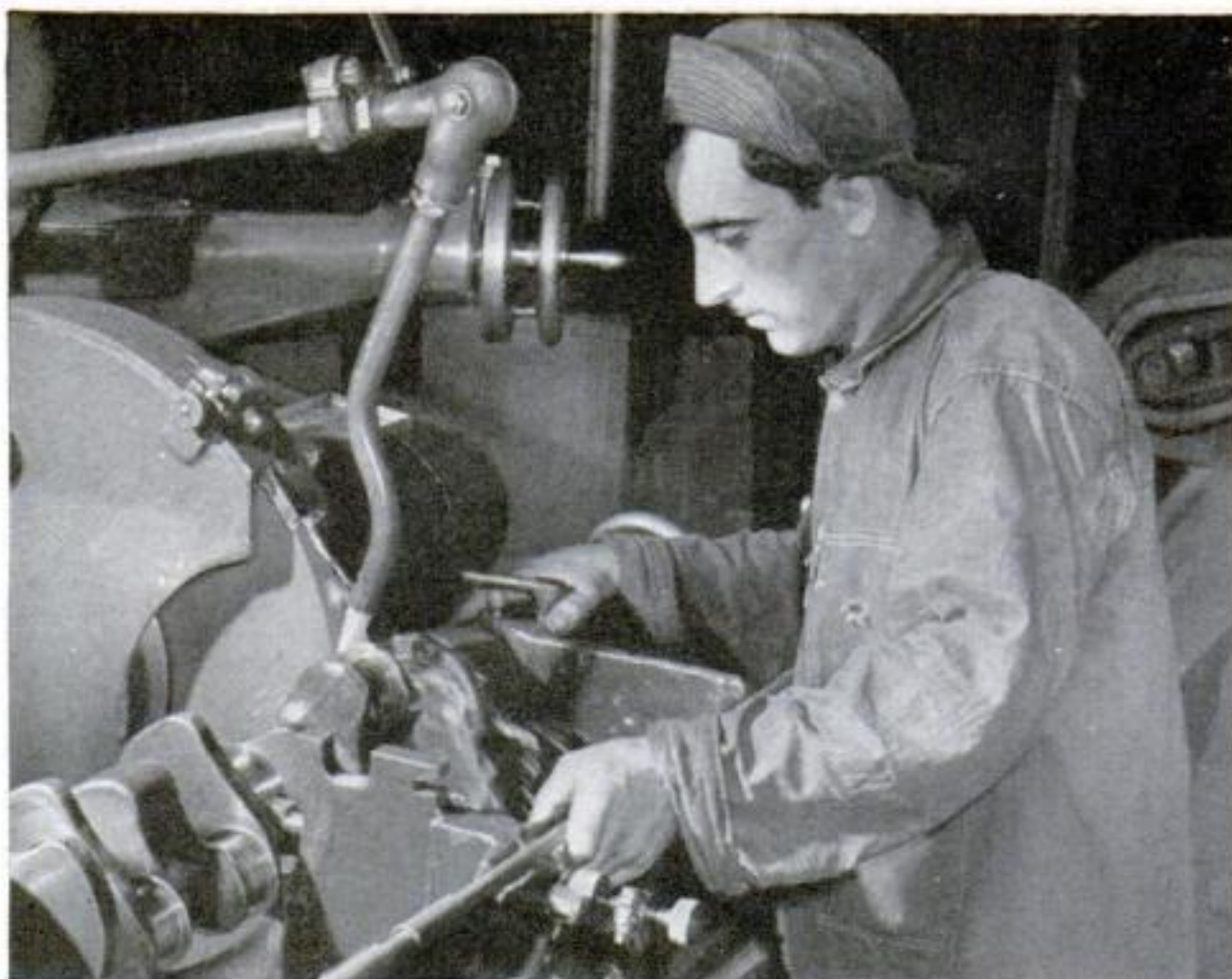


Internal-combustion engines supply motive power for the modern army, so they get a lot of attention at Holabird. Students put their studies to practical use repairing vehicles in actual service

Diagrams like the one at the left, with the parts mounted on it, help students to understand an ignition system. Movies and lectures also aid in initiating the tyro into the mysteries of automotive design

Use of shop tools is made part of the course. This soldier, learning to grind crankshaft bearings, knows that he is acquiring skill which will bring him promotion while he is in the Army, and equip him with a valuable trade when he returns to civilian life

Running a milling machine seems like a far cry from the manual of arms. However, enlisted men at the school don't escape from Army discipline. They are organized in companies and each man has to carry his share of Army chores such as kitchen police and cleaning up the barracks



almost able to do it with their eyes closed.

Before they are considered finished mechanics, the students are given stiff practical tests to see how well they have learned their lessons. These are problems of the kind that a soldier in the field might be faced with. A student in motor maintenance, for instance, will be assigned to an engine which has been put on the blink in some unobtrusive way. Maybe the fuel pump has been plugged with a tiny bit of cotton, tucked away where it will be hard to find. Or a distributor has been timed just far enough off the proper point so that an engine will run, but not well. Possibly valve tappets will have been loosened, or the cooling system blocked. Whatever it may be, the student assigned to a particular job is supposed to find the trouble and correct it, working against time.

The more adept of the students are singled out and given special training that will enable them to act as foremen, or to train other soldiers when they return to their camps, because even with the increase in school activities, the Army can't hope to train mechanics in the schools as fast as they are needed. Officers go through the same courses as enlisted men in many cases; in others they are taught more about supply and administration after they have their basic training.

A good portion of the work of the students is put to a double use. Quartermaster Corps vehicles in need of repairs are sent to the school shops, where the students, under the guidance of their instructors, make necessary repairs, learning while they are working.

Even though they are studying seven hours a day, six days a week, and frequently have homework to worry over in the evenings, the boys don't get out of Army discipline. Students at the school are organized into companies and each soldier has to do his share of kitchen police, cleaning up the grounds and barracks and other chores.

But most of them like it. They are learning things that may help them make a living when they go back to civilian life, and that will aid them in getting promotions while they stay in the Army. And at the same time they are helping the Army keep 'em rolling.

USEFUL AUTO HINTS



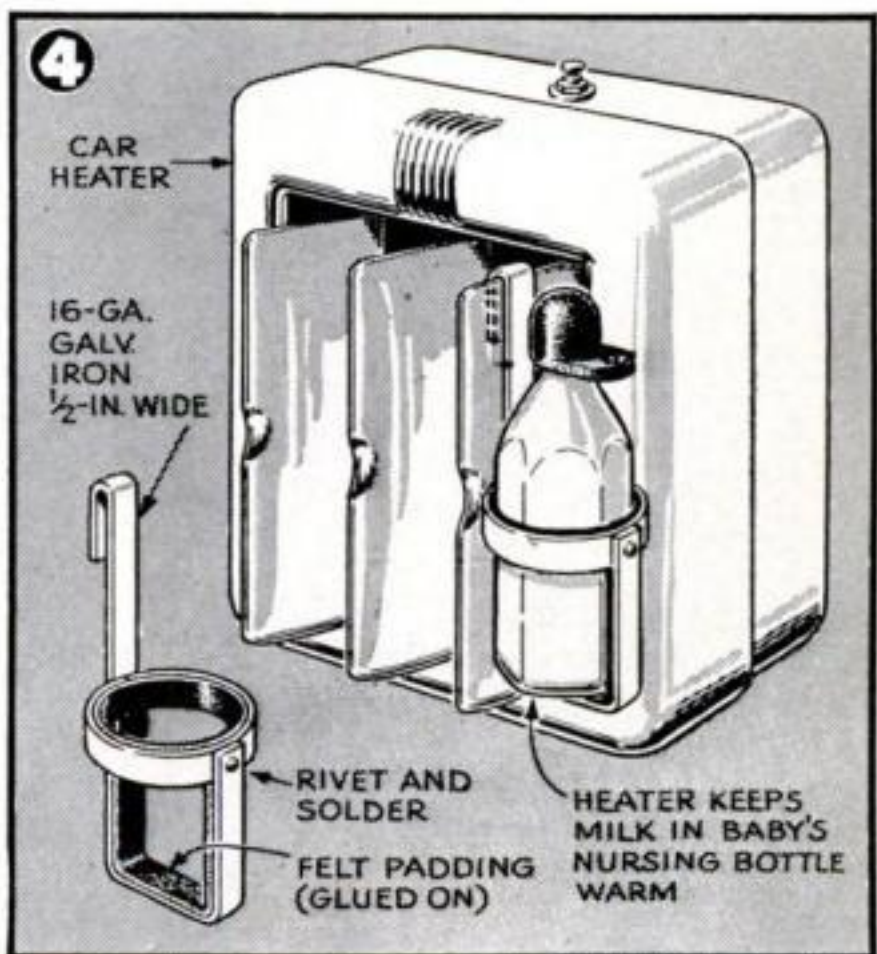
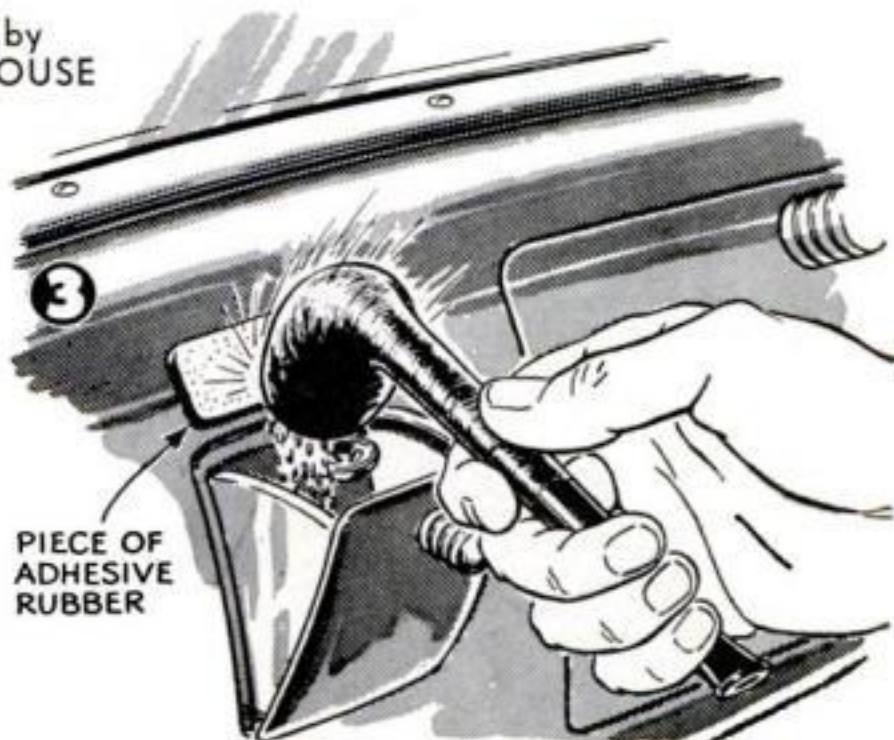
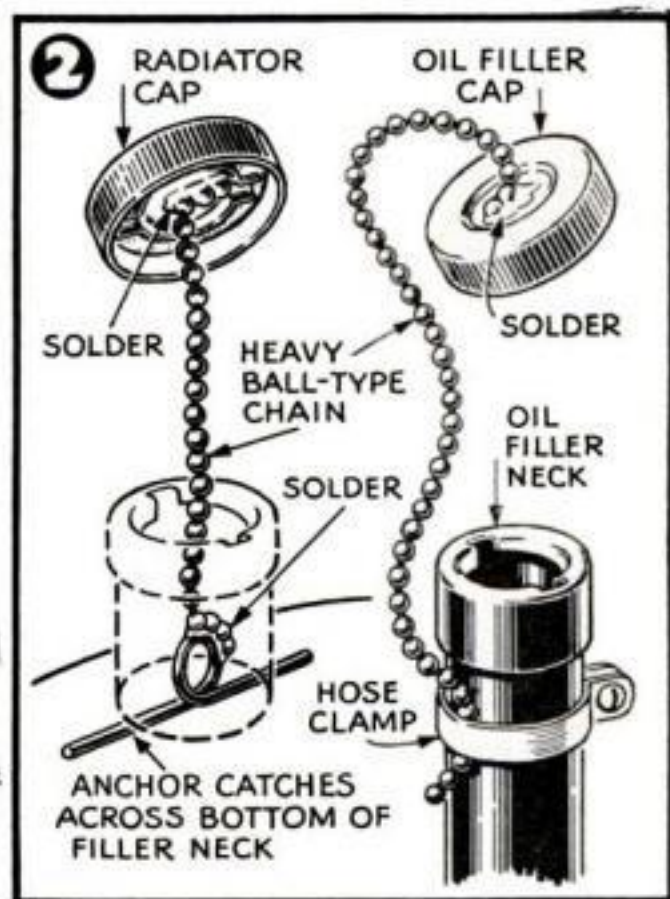
Drawings by
STEWART ROUSE

1 AN EFFICIENT SCRAPER for removing ice and frost, or just plain snow, from the windshields and windows of cars can be made from a piece of stiff fiber board, cut to the size and shape shown. Put a couple of these in your glove compartment when you ready your car for winter. They will come in handy some day.—H. A. T.

2 TO PREVENT LOSS of radiator and oil-filler-pipe caps of your car, solder heavy ball-type chains to the caps and connect the other ends with anchors of the types indicated in the drawings. The anchor holding the radiator cap should be made of brass or copper. The oil-filler-cap chain uses an outside clamp.—W.H.Q.

3 A DASHBOARD PIPE BUMPER directly over a pull-out-type ash tray can be made by simply affixing a small piece of adhesive-backed rubber to the panel above the tray. Tapping the pipe bowl against the rubber will quickly empty the ashes into the open tray, making it unnecessary to use two hands for the chore.—A.L.G.

4 TO MAKE A BABY-BOTTLE WARMER for use on automobile trips, bend two strips of galvanized iron to the shapes shown and rivet them together, adding a drop of solder or two for rigidity. Hung over a door of the car heater, the unit holds a bottle near enough to the blast of warm air to heat it as much as desired.—W.C.F.



GUS KEEPS 'EM ROLLING

By MARTIN BUNN

"DUNNO what we're going to do," Joe Clark gloomed to his Model Garage partner, Gus Wilson. "It was tough to lose Harry to the Army. Now he's gone and got himself into that officers' training school, so he'll stay in the service a long time, and when he comes out it isn't likely that he'll be willing to come back to work as a grease monkey. Ever since he left, every half-way-decent mechanic we've managed to get hold of has either enlisted or been blown away by the draft or has quit us to go to work in some defense industry.

"Oh, I ain't kicking—I'm just as patriotic as the next fellow. But how are we going to keep this business running? That's what I'd like to know! Since folks have realized that they're likely to have to make their cars do for a long time we're getting more business than we've ever had before. We need two good mechanics right this minute—we could use three. And what can we get? Nothing but kids fresh out of high school. What the heck *are* we going to do, Gus?"

Gus looked up from the complicated gadget he had on his workbench—it's an idea that he's working out experimentally before he sends it to the National Inventors' Council down in Washington with what we all think is the well-founded hope that it will be a help in the good work of making Hitler less of a nuisance than he is now. "What are we going to do?" Gus

"Going to hire a girl for the office and I'm coming out in the shop," said Joe. Gus looked downright scared

repeated seriously. "We're going to do the only thing we can do—keep right on trying our darndest to keep our customers' cars rolling. That's our job, Joe, and it's an important job. We'll just have to do the best we can with whatever sort of help we can get. Quit your worrying and hire one of those kids you've been interviewing. It might happen that I could turn him into something useful."

"O.K.," Joe agreed, without enthusiasm. "And I'll tell you something else I'm going to do. I'm going to hire a girl to do most of the work in the office, and I'm coming out here in the shop. Lord knows that I don't pretend to be a mechanic, but there must be some things I could do."

Gus looked downright scared. Joe's few attempts at mechanical work have been far from successful. "That's a swell idea, Joe," he said soothingly, "but for the time being



it would be a lot more sensible for you to keep on running this outfit from the front office. That's *your* job. If the time comes that I need you out there, I'll tell you so. That sounds like Doc Foley's horn."

It was, and a moment later Dr. Foley came in with a worried look on his usually cheerful face. "There's something seriously wrong with my car," he announced. "I think it must be the fuel pump."

"What are the symptoms, Doc?" Gus wanted to know.

"Yesterday afternoon," Dr. Foley told him, "I was doing about forty when I came to that steep hill four or five miles up the road. Half way up it my motor began to labor, and although I stepped on the gas hard it went dead before I got to the top. From the way it died I thought I was out of gas, but the gauge showed that the tank was three quarters full. I took a look under the hood, and so far as I could tell everything was all right—not that I know much about motors. Anyhow, when I got back in the car and stepped on the starter, away she went as nice as you please!

"I was on my way to see the Dawsons' little girl—she's got the measles. Dawson is a fellow who enjoys fussing with his car, so I told him what had happened. After he had done some checking on my motor, and found that it was running perfectly, he said that probably a speck of dirt had clogged one of the carburetor jets and then worked its way out again, and that I wouldn't have any more trouble.

"I forgot all about it until the same thing happened again today. In fact, it happened three times while I was on my rounds. I know it's after your working hours, but I have a lot of calls to make now that young Dr. Smyth has gone in the Navy and I've taken over his practice, and I just can't

afford to be driving a car that I can't depend on."

"Drive her right in, Doc," Gus invited. "Working hours are whenever I'm here. That goes for the duration!"

By the time Gus had locked his gadget in the office safe Dr. Foley had driven his car into the shop.

Gus looked at its speedometer. "Thirty-six thousand four hundred," he read. "How long have you had this fuel pump, Doc?"

"Why, it's the one that came on the car," Dr. Foley told him. "Anything wrong about that?"

"Maybe not, and maybe there is," Gus said. "Seems to me that it's a good idea to install a new pump every 20,000 miles or so—just to be on the safe side. There's nothing that makes a man feel more helpless than to have his fuel pump go bad when he's ten miles from nowhere in the middle of the night, and leave him with no way of getting gasoline from his tank to his carburetor. But maybe your trouble isn't in the fuel pump at all. I'll have to do a little checking."

He cleaned a small amount of sediment out of the pump bowl. Then he replaced the bowl, opened the gas line from the pump to the carburetor, and stepped on the starter. Gasoline spurted out of the pump. "Your fuel pump is O.K.," he told Dr. Foley, "but I still think that it would be a good idea to put in a new one, considering the mileage. The chances are that the trouble is in the carburetor."

He cleaned out the short line from the pump to the carburetor. Then he took the carburetor apart and blew its jets clean with compressed air. Then he reassembled the carburetor, and again stepped on the starter.

The engine took off promptly and ran smoothly.

"It seems all right now," Gus said. "But it seemed all right a couple of times before, and then went dead on you. Got time for me to take her out for a little road test, Doc?"

"Sure, go ahead," Dr. Foley told him.

Gus was gone for the better part of a half hour. "How was she? All right?" the doctor asked when he drove back into the shop.

"Nope—she's still all wrong," Gus said. "Did the same thing with me that she did with you. The engine drifted to a stop on a hill, but took off fine



Keeping one ear close to the top end of the pipe, Gus listened intently

again when I stepped on the starter. You'll have to let me do some more checking this evening, Doc. Right now I've got to hustle down to the Park House to get my dinner, or the dining room will be closed. I'll drop you off at your house on my way, and I'll bring your car around to you on my way home tonight. If you should get a hurry call before I've got it fixed, phone me and I'll bring my bus around for you to use. O.K.?"

When Gus got back to the Model Garage after he'd eaten a hurried dinner he found the lights burning in the office and Joe Clark busy over his ledgers, and the lights burning in the shop and Ez Zacharias, his postman's cap on the back of his shaggy head, chewing tobacco industriously and gloomily contemplating his mud-plastered R.F.D. sedan. "Joe said you'd be back," Ez explained. "Say, Gus, I'm right behind the eight ball. My ol' bus sounds like all her connecting-rod bearings was burned out. Take a look at the ol' girl, will you?"

"I will if you want to wait until I've found out what's the matter with Doc Foley's car, and fixed it up," Gus told him. "His job's ahead of yours, and I promised it to him for tonight."

"I got lots of time," Ez assented comfortably. "The P.O. Department ain't got us R.F.D. fellers deliverin' mail at night—not yet, anyhow. I'm a-takin' this-here World War Two easy-like—they danged near wore me down over there in France in the first one. 'Course if them Nazis ever came over here I'd feel different. I'd get me a machine gun and show some of these kids who're swaggerin' around in uniforms how we used to—"

He went on sounding off while Gus, paying mighty little attention to him, re-checked the fuel pump and carburetor of Dr. Foley's car. Again he could find nothing wrong with either.

Finally Ez interrupted his monologue. "What's the matter with that crate?" he demanded. Gus described the difficulty.

"Huh!" Ez grunted. "Bet it's the carburetor. Carburetors are the cause of about three quarters of the trouble you have with automobiles. They're like kids' stomachs and hosses' bellies! Hey, look here! When you took the cover off that carburetor I seed that the float bowl was near empty. That ain't natcheral. What's the cause of it, hey?"

Gus stared at him. Then he stared at the float bowl. "You're right, by gum!" he said. "I never thought of that. You are of some use, after all, Ez! Let's see, now."

He examined the float bowl carefully. Then he laughed. "That's one on me," he acknowledged. "See what's wrong, Ez? The float needle is worn to a wedge fit. It sticks so tight when the float bowl is emptied that it doesn't open when the float-arm pressure is removed. Then the engine stops because it isn't getting any gas—and then when you step on the starter the carburetor gets a little jar which loosens the float needle, the gas flows again, and the engine starts. I'll just lap out the valve seat a little with some very fine valve-lapping compound, and Doc won't have any more trouble with it. First time I've ever run into that one. You're some trouble-shooter, Ez!"

Highly pleased with himself, Ez chewed his tobacco placidly and amused himself by scoring an occasional bull's-eye on the waste box while Gus put the valve into workable condition. Then he went into the office and telephoned Dr. Foley. "Your car's O.K. now," he told him. "It wasn't the fuel pump, after all, but it would be good business to put a new one in just the same. How about it?"

"Whatever you say," the doctor told him.

Gus came back into the shop and installed a new fuel pump. Then he turned to Ez. "Now for that wreck of yours," he said. "What did you say is the matter with it this time—a burned out connecting-rod bearing? Let's hear your sad story."

"She's sad, all right," Ez said, grinning. "This morning on my route I had to tramp on the gas pretty hard to make a steep hill, and there was a rap somewheres in the car's innards. Every hill I went up after that the rap got louder. It sounded to me like a connecting-rod bearing gone flooey."

Gus raised the hood. "Start her up, will you?" he said. Ez climbed into his car and started the engine. Gus listened intently for half a minute. "There's a rap, all right," he decided, "but I can't tell where the noise is coming from."

He went over to his workbench and came back with a three-foot length of iron pipe. "Speed her up a little," he told Ez. Keeping one ear close to the upper end of the pipe, he (*Continued on page 218*)

GUS SAYS:

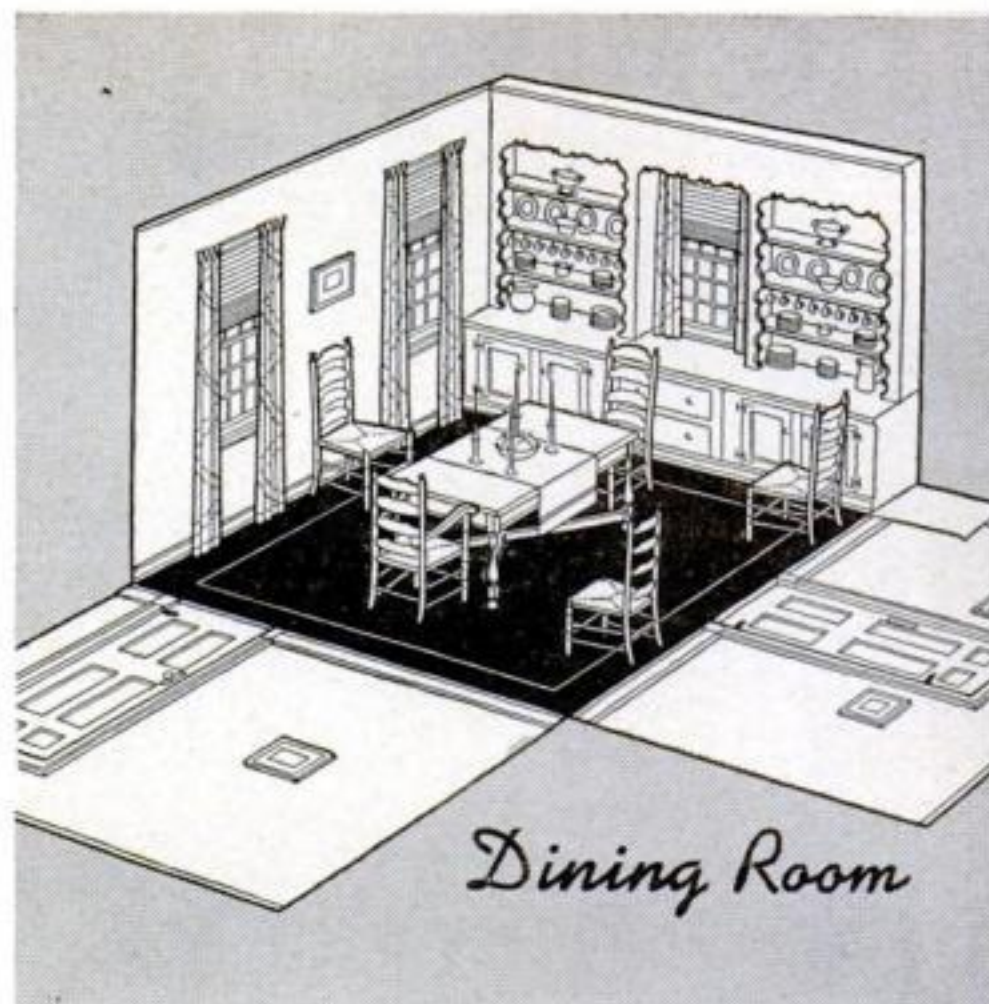
Few seem to realize that most engine trouble shows up first right under your nose—on the dashboard instruments! Glance at them often as you drive and someday you may stop serious trouble before it happens!

HOME *and* WORKSHOP



Call it charming, picturesque, or what you please, but a Cape Cod house really looks like home. This design won third prize in our house contest **NEXT PAGE**

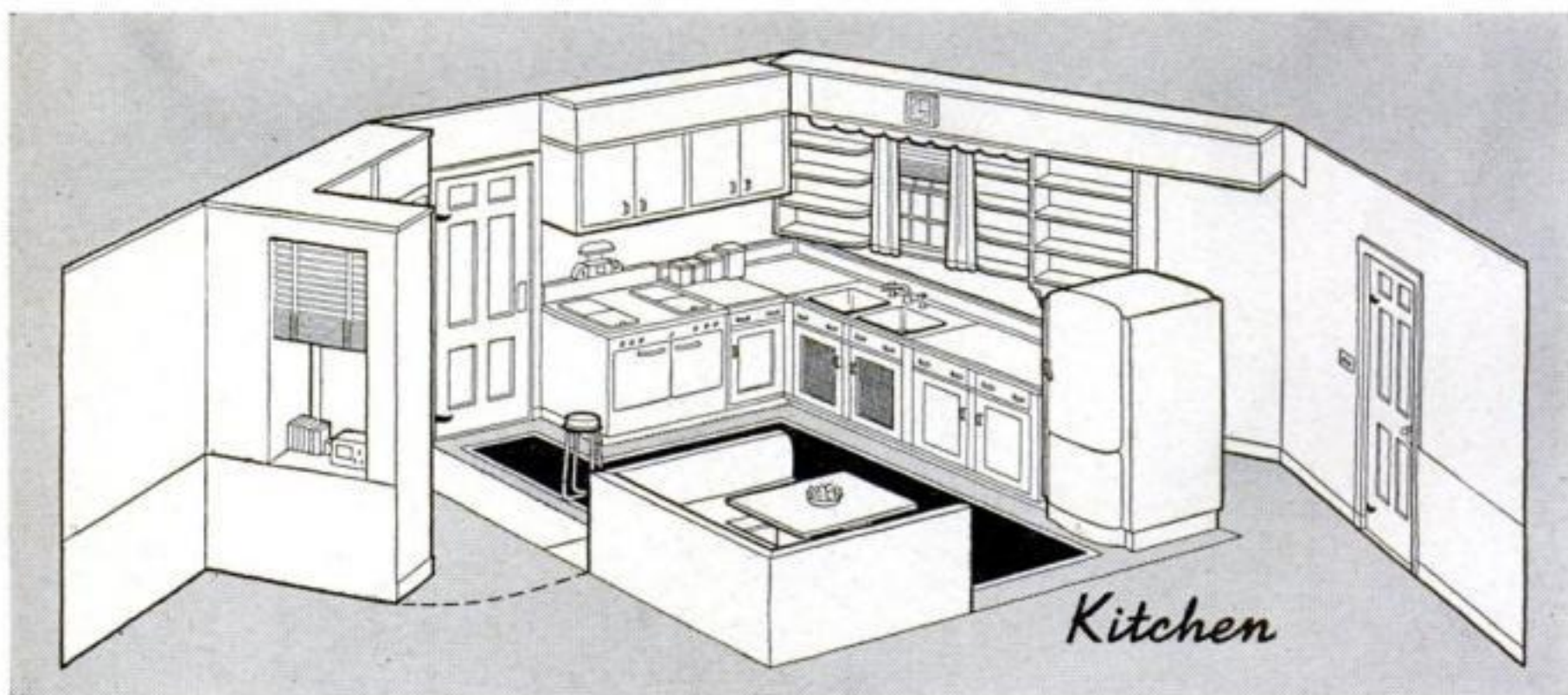
First in popularity among our readers is the lovely, livable Cape Cod style. More houses of this type were submitted in our home-planning contest than any other. The best of these is the house designed by George and Margaret Mallory, of Evanston, Ill., who were awarded third prize in the contest (P.S.M., Oct. '41, p. 138). Their entry was remarkable not alone for the excellence of the design, but also for the completeness of the drawings and description, which filled a large portfolio (see page 154). Following is a considerably condensed version of their specifications, illustrated with plans that have been redrawn to save space, although nothing essential has been omitted.



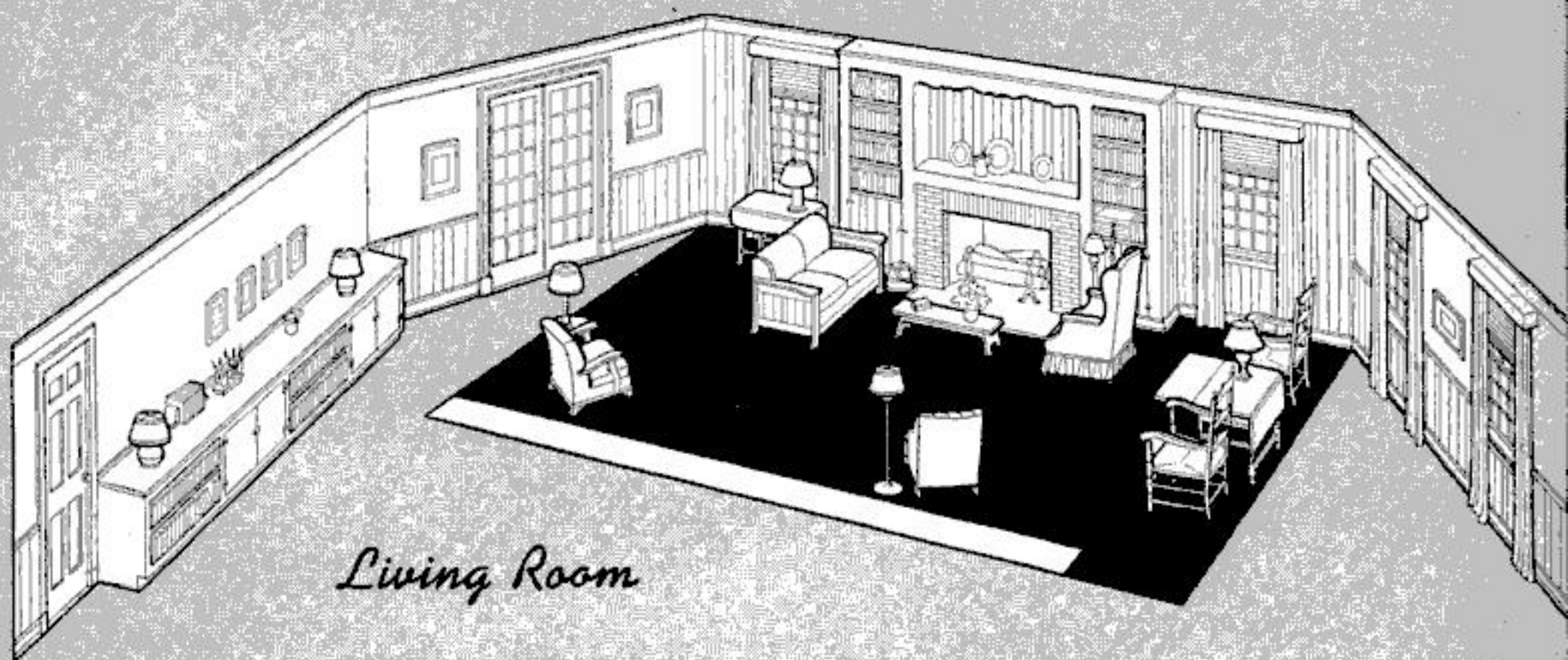
A Welsh dresser is built into the east wall, surrounding a window that overlooks the flower garden

THESE are the working plans for our intended home, which we have spent two years designing. Now, we believe, it perfectly suits the needs and demands of our family.

It is Cape Cod in style, with modifications that do not detract from the type, but add to convenience. The front elevation is typically low—one story with an uninterrupted roof line; the rear, however, is a full two stories to increase the cubage of the second floor, enabling us to have three rooms as against the traditional single room or possibly two. This also allows for an extra



This kitchen is a housewife's paradise. Note that a partition separates the breakfast nook from the rest of the room; it is fitted with a Venetian blind for privacy, and there is space for radio and books



For clearness, the living room and several other rooms are shown as if the walls had been opened up so that all four can be seen at once. See the floor plans for the exact shape, orientation, and dimensions

Cape Cod House Wins Third Prize

IN OUR HOME-PLANNING CONTEST

room on the first floor, necessary for our growing family.

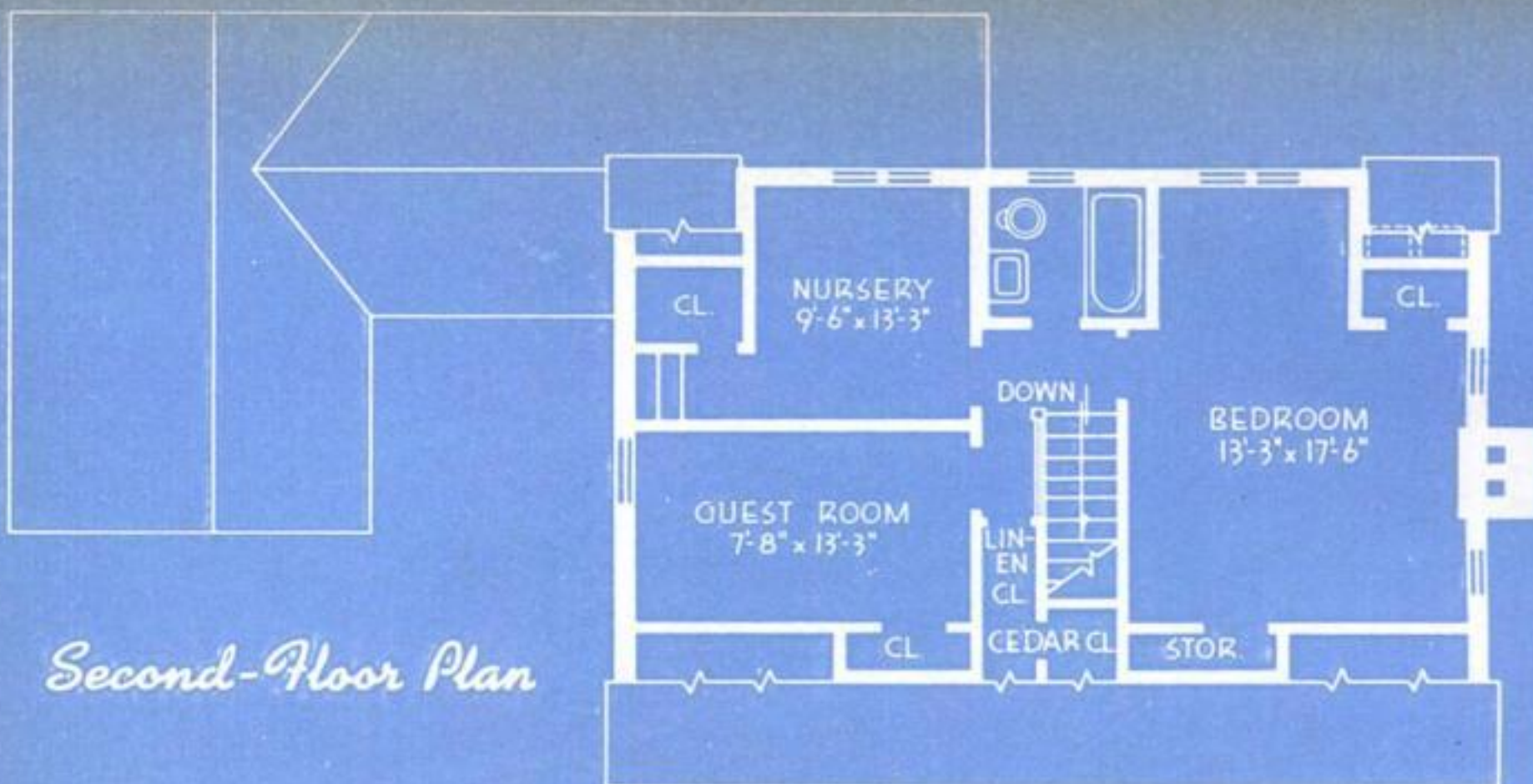
A further modification is a flagstone terrace at the rear of the living room to make a more attractive vista and entrance to the garden. A screened porch between the house and garage adds to the enjoyment of the garden and, together with the garage, enables us to place the small flower garden, so usual between the picket fence and the house, at the side of our house. Thus we preserve the appearance of fence and garden, yet retain the full expanse of front lawn.

Inside we adhere to Cape Cod features except where modifications increase convenience. The kitchen and bathroom appointments are admittedly modern. The lighting fixtures are not strictly in keeping, and the doors, except for one, are paneled

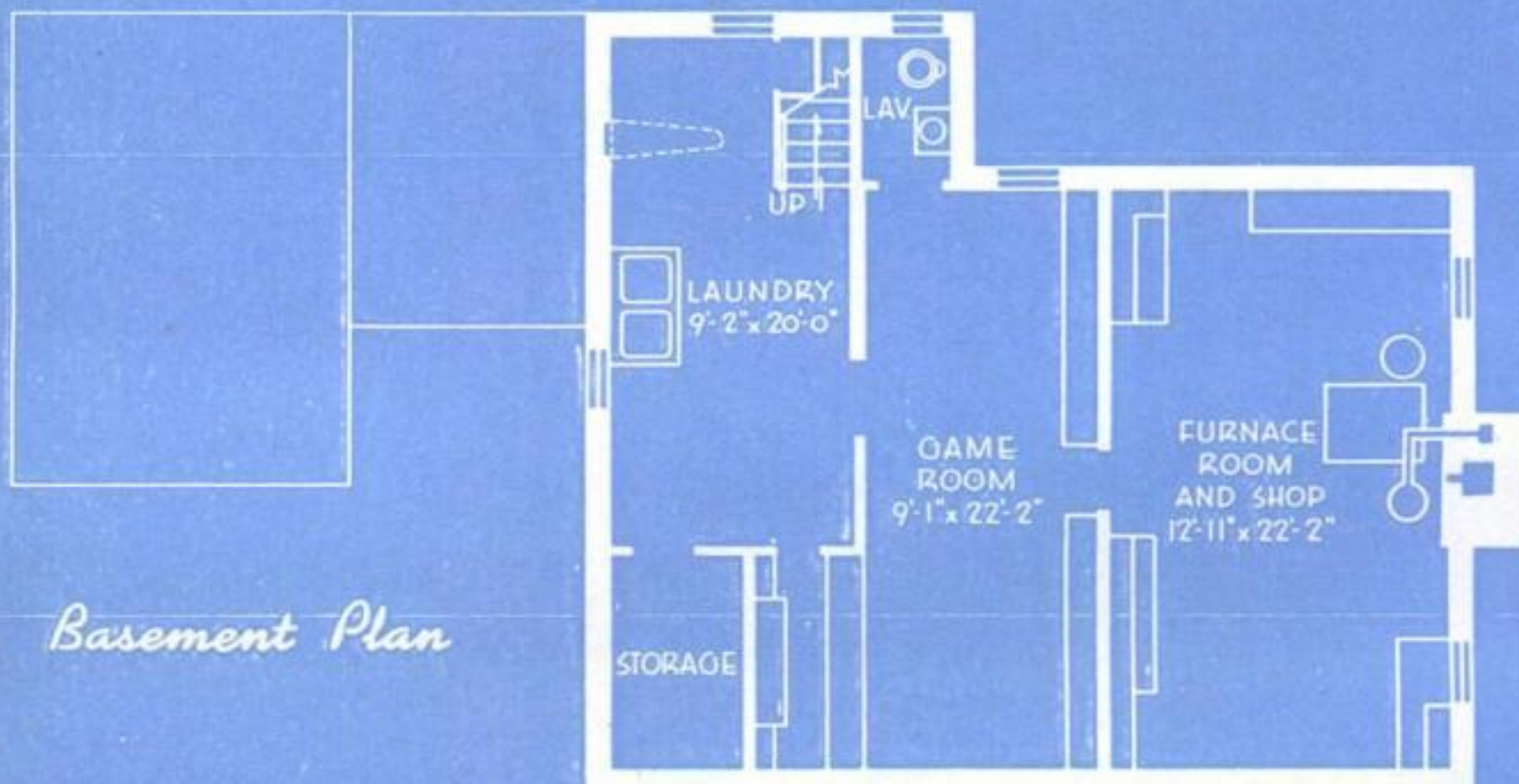
rather than batten-backed. The maple furniture retains the period influence, but is light, not heavy or rough, and allows for more freedom in decoration.

Our choice of style is economical in several ways. The house is compact, which makes heating inexpensive. The wall lengths inside as well as out are straight, not cut up, and this lessens the construction costs.

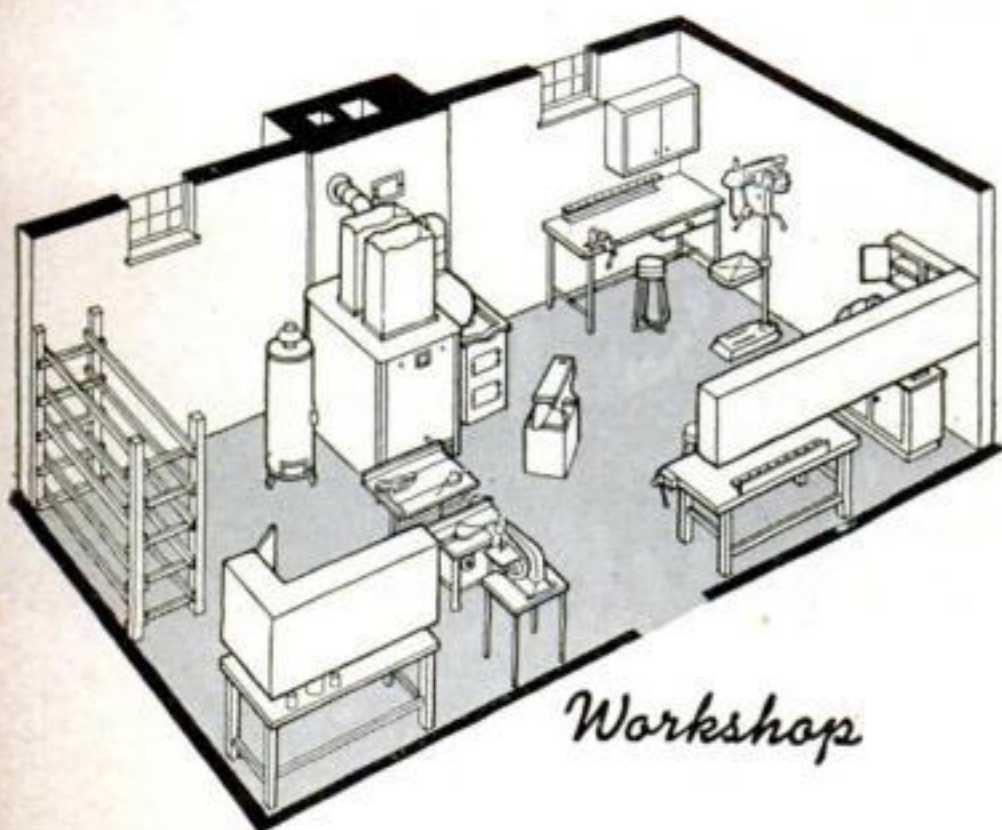
The house itself, without the extensions at side and rear, has a 34' frontage and is 24' deep. With porch and garage added, it can be built on a 75' lot with 5' to spare, or, preferably, on an 80' lot with 10' to spare. If the porch and garage were placed back of the house, a 50' lot would be wide enough. The depth should be 150' or 160'. With the addition of 5' on the east side of the garage, it would be possible to have a two-car ga-



Second-Floor Plan



Basement Plan

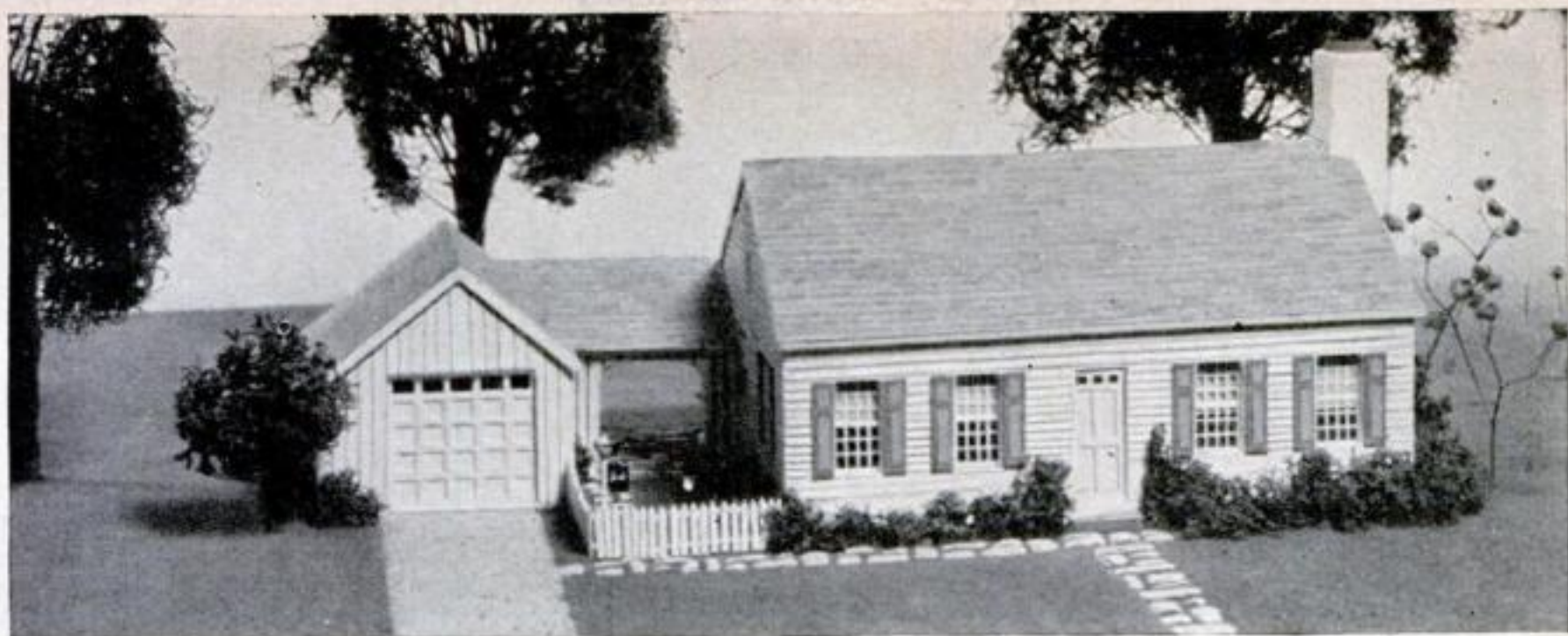


Workshop

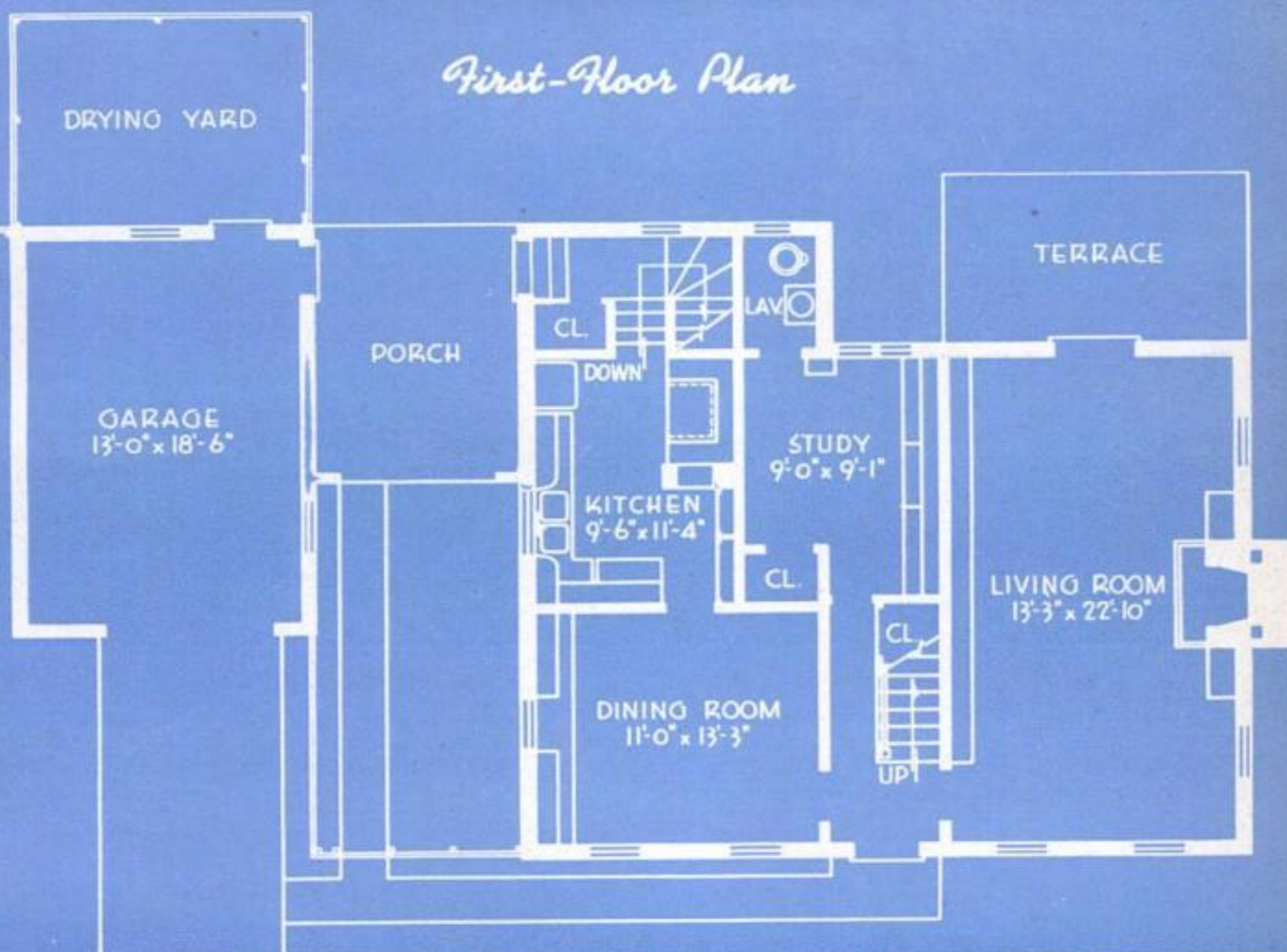
rage, since the present plan calls for 4' more space than necessary, which we intend to use for storing tools.

We wish to have the house face north since the only rooms having windows on that side also have another exposure. This permits eastern sun in the kitchen and dining room, and southern light in the nursery and study, which have windows in only one wall.

Costs, size of family, and income. The house will contain 20,278 cu. ft., and the garage 1,804 cu. ft. At 35 cents per cubic foot, the cost of the house will be \$7,097 and



First-Floor Plan



All drawings by Sigman-Ward; model by Louis Fromm, architectural model maker

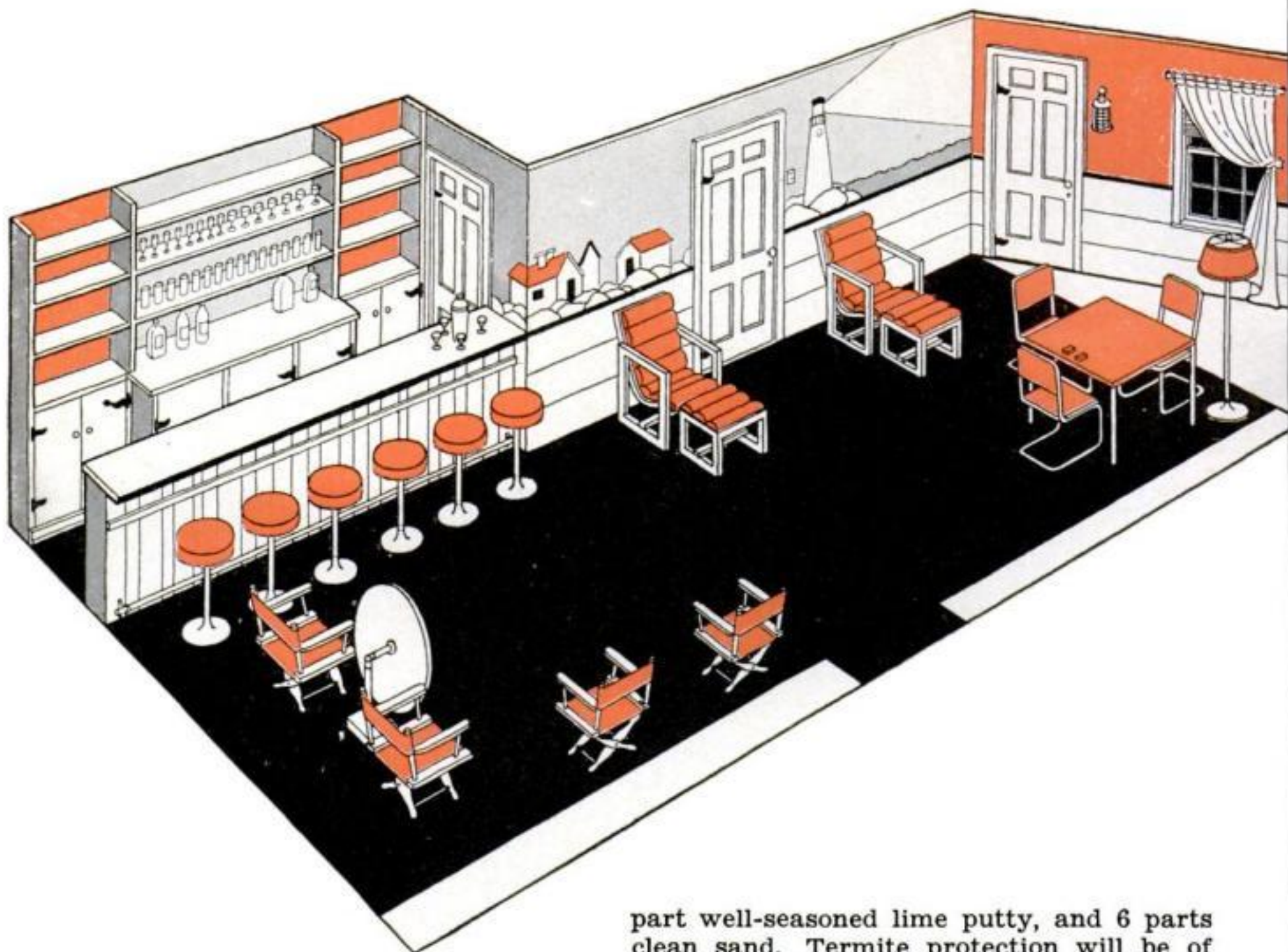
of the garage \$630, a total of \$7,727. There will be an allowance of \$900 for those extras not included in the contract, bringing the cost to \$8,627. An architect will be employed. If his fee is 8 percent, the savings effected in lessening that amount for extras will probably bring the added cost down to 4 percent, or \$345.

The largest lot we could need would have a frontage of 80'. In many suburbs now being developed in our vicinity, land can be bought for \$50 per front foot or less, which would bring the cost of our lot to \$4,000 at the outside. For the 50' lot we could com-

promise on, the cost would be only \$2,500.

The family, at present, consists of husband, wife, and daughter, under two. The Mallory income is \$250 a month, or \$3,000 a year. Therefore, the house, exclusive of lot, will cost two and two-thirds times the yearly salary.

Excavation and foundation. The basement excavation will be deep enough for the house to appear to lie close to the ground as a Cape Cod cottage should. The height of the finished basement will be 7½', and the two floors above, 8½'. Heating ducts, cutting into headroom, will be avoided



where possible; where not, they will be rectangular.

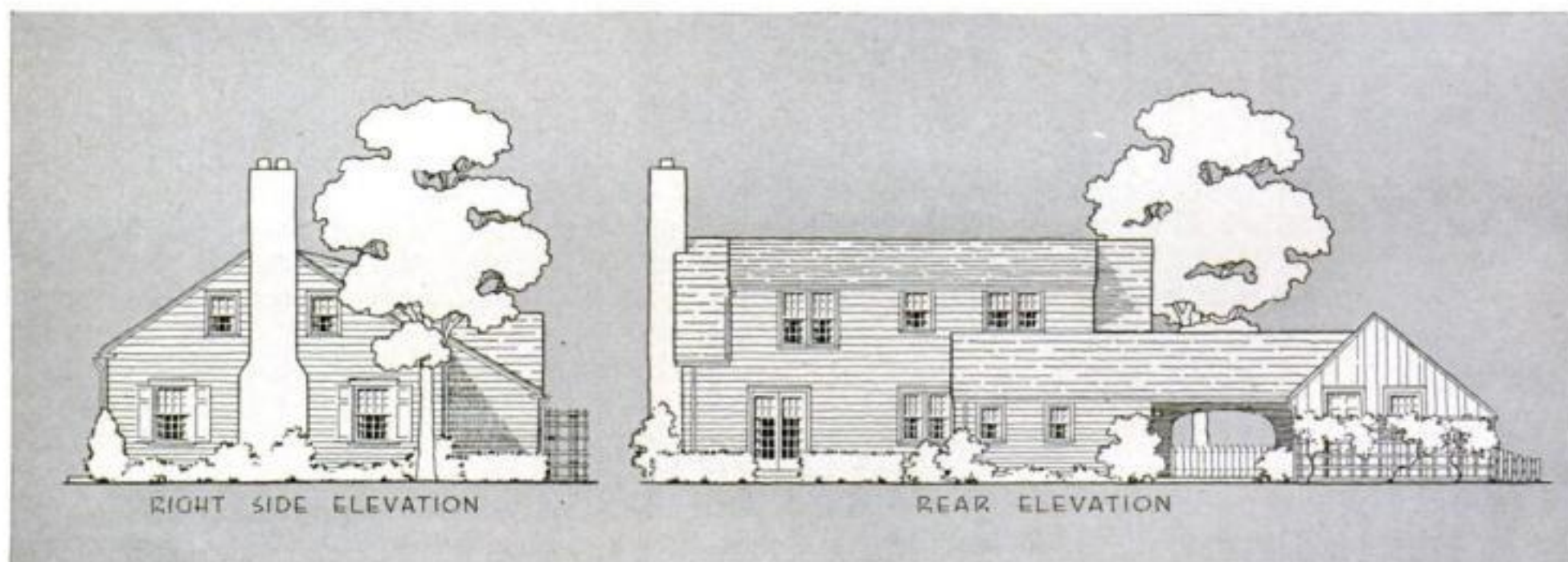
The footing will be on solid earth with the base square, 15" wide and 12" thick. We will use 2,000-lb. concrete, 6 bags of Portland cement to the cubic yard, and $6\frac{3}{4}$ gal. water to the sack of cement, including water contained in the aggregate.

The foundation walls will be 10" concrete with a toggle to receive a hard-burned shale-brick water table. The table is to be laid in mortar of 1 part Portland cement, 1

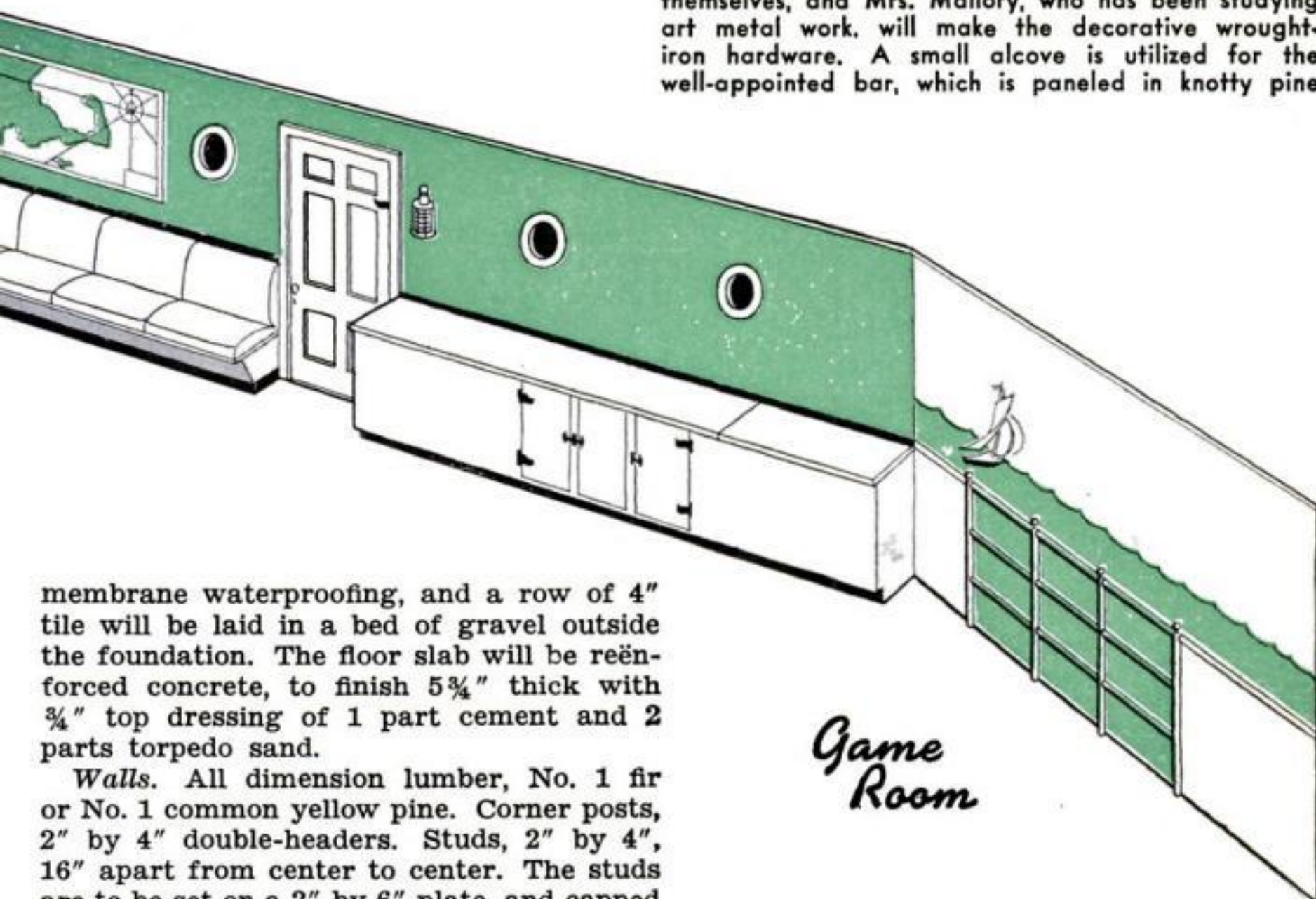
part well-seasoned lime putty, and 6 parts clean sand. Termite protection will be of copper sheet placed at the top of the foundation wall.

The frame house will be anchored to the foundation with bolts embedded in the concrete wall. The sill, too, will be bolted to the foundation and laid in cement. The joists will be No. 1 yellow pine or No. 1 fir, supported by interior partitions, doubled around all openings.

The foundation wall will extend above the ground. The basement windows will have concrete areaways, with a vertical drainpipe reaching to the foundation tile. The wall will be waterproofed with asphalt



When it came to the game room, the Mallorys really let themselves go. They plan to paint the murals themselves, and Mrs. Mallory, who has been studying art metal work, will make the decorative wrought-iron hardware. A small alcove is utilized for the well-appointed bar, which is paneled in knotty pine



membrane waterproofing, and a row of 4" tile will be laid in a bed of gravel outside the foundation. The floor slab will be reënforced concrete, to finish 5 $\frac{3}{4}$ " thick with $\frac{3}{4}$ " top dressing of 1 part cement and 2 parts torpedo sand.

Walls. All dimension lumber, No. 1 fir or No. 1 common yellow pine. Corner posts, 2" by 4" double-headers. Studs, 2" by 4", 16" apart from center to center. The studs are to be set on a 2" by 6" plate, and capped with a double plate of the same dimensions.

The sheathing will be 6" boarding nailed on diagonally. It will be covered with a layer of kraft building paper. The cypress siding will overlap to be waterproof.

Balsam wool batts, sealed in waterproof paper bags, will be placed in the outer walls and roof. Over this will be gypsum lath (fire resistant). There will be metal corner beads at all the exposed plaster corners.

Plaster will be a coat of brown plaster consisting of 1 part gypsum to 3 parts sand laid to screeds (guides); the finish coat, 1 part aged lime putty and 1 part plaster of Paris, except in kitchen and baths, where 1

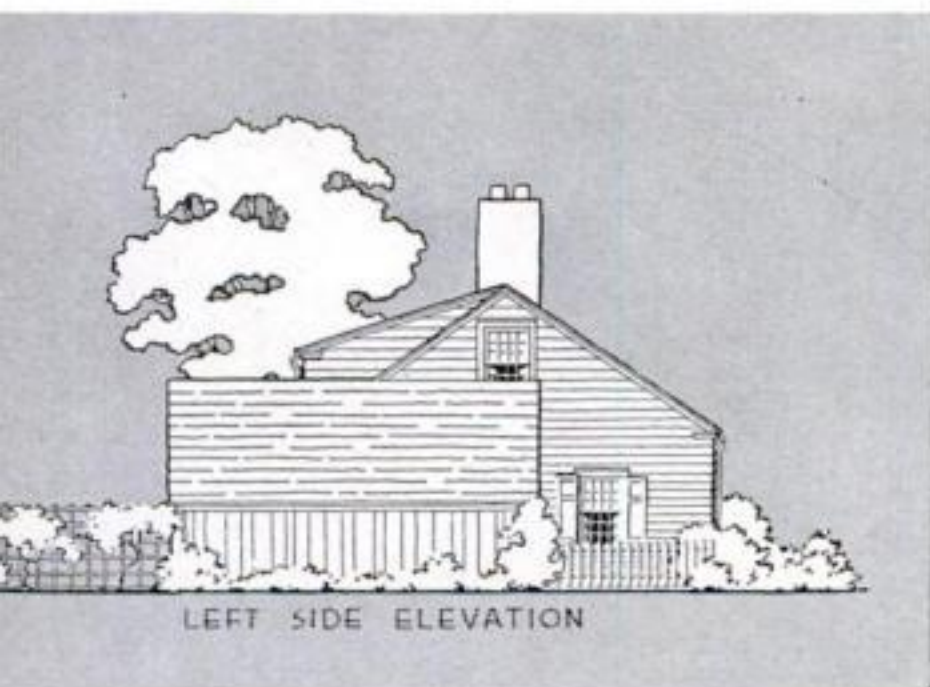
part aged lime putty and 1 part Keene's cement will be used.

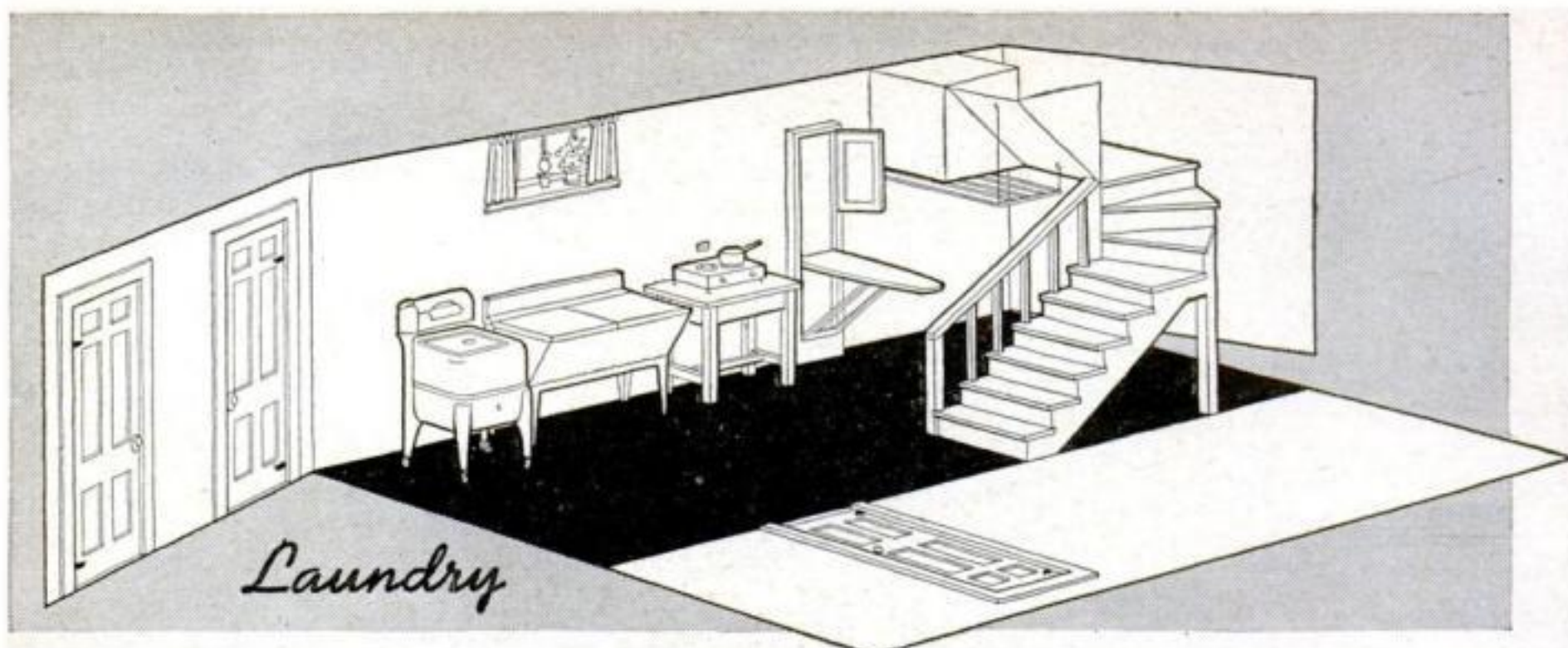
Roof. Rafters are to be 2" by 8" No. 1 fir or yellow pine. Collar beams above the mid-point of the rafters will keep the roof from spreading. Sheathing will be laid horizontally, tight, and double-nailed at every rafter. Over this one layer of waterproof paper will be nailed. Shingles will be asbestos—a weathered shade resembling wood.

Flashings will be of 16-oz. copper. Gutters, of 16-oz. copper, will be 5" half-round with a rolled edge, secured every 4' with copper hangers. The conductor pipes will be square, of 16-oz. hard copper.

Floors. Joists, 2" by 10", are to be spaced 16" apart on centers. They will overlap on all bearing partitions and be spiked to them and to each other. The subflooring will be laid diagonally. On top will be two thicknesses of 30-lb. wool felt for sound deadening. The finish floor will be of random-width Ponderosa pine, grade B and better, 13/16" thick. In the bathrooms and kitchen, the floors will be 2 $\frac{1}{4}$ " by 25/32" second-quality maple, covered with linoleum.

Windows and doors. Wooden window and door frames will be stock sizes for economy, back primed upon arrival to preserve them and prevent warping. The grounds, or





On this and the facing pages are opened-up views of the laundry, study, nursery, and downstairs hall. Laundry equipment includes tubs, drying lines, ironing board, washing machine, and small electric stove

nailing strips, are to be fastened to the walls flush with the finished plaster. The windows will be authentic Cape Cod, twenty-four and twelve light, double-hung. Zinc weatherstripping will be installed at all windows and exterior doors.

Porch, door, and window screens will be 16-mesh copper wire set in frames of $1\frac{1}{8}$ " white pine. Glass storm doors and windows are provided throughout. Overhead-type garage doors will have square panels with windows in the top row. French doors will be used at the south end of the living room. Room doors will be six-paneled.

Trim. The trim throughout will be of birch. The walls in the living room and game room are to be paneled horizontally 3' up. The west wall of the living room is paneled in random-width knotty pine vertically from floor to ceiling, as is the alcove of the game room. The west wall of the front hall and the stair well are finished in the same manner. There are four false boxed-in beams of birch in the ceiling of the living room. Base moldings are 6" wide in every room except baths and kitchen. In the bathrooms, wall board resembling tile reaches 3' from the floor, and in the bath alcove to the ceiling.

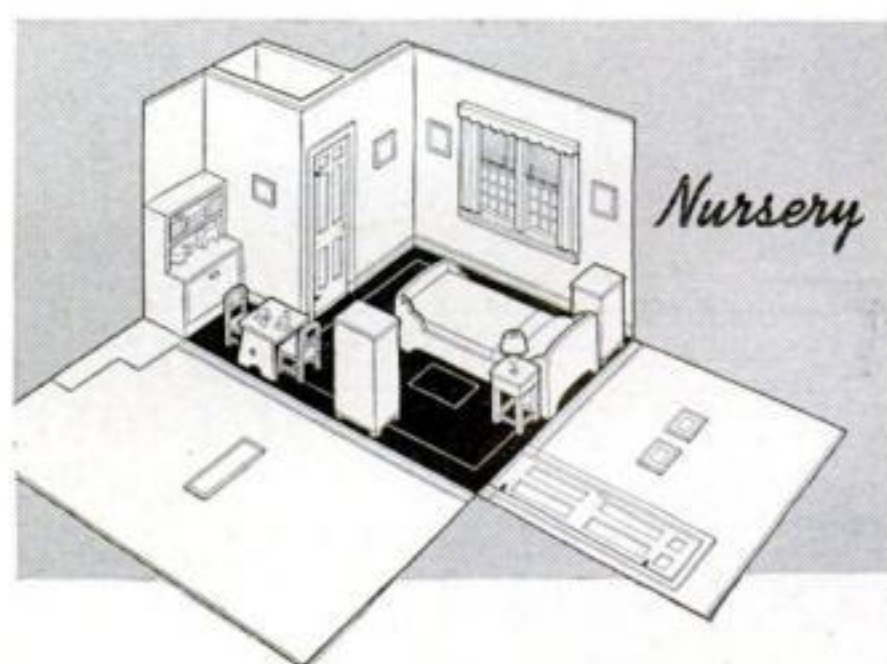
Stairs. The stairways have ceiling-height headroom all the way up. The pitch, to avoid steepness, calls for 11" treads (including the nosings) and $7\frac{1}{2}$ " risers. The finish on the front stairs will be white painted risers and mahogany-finished birch treads. The basement stairs will be painted and have a rubber mat nailed on each tread. The front step is of mortared flagstone.

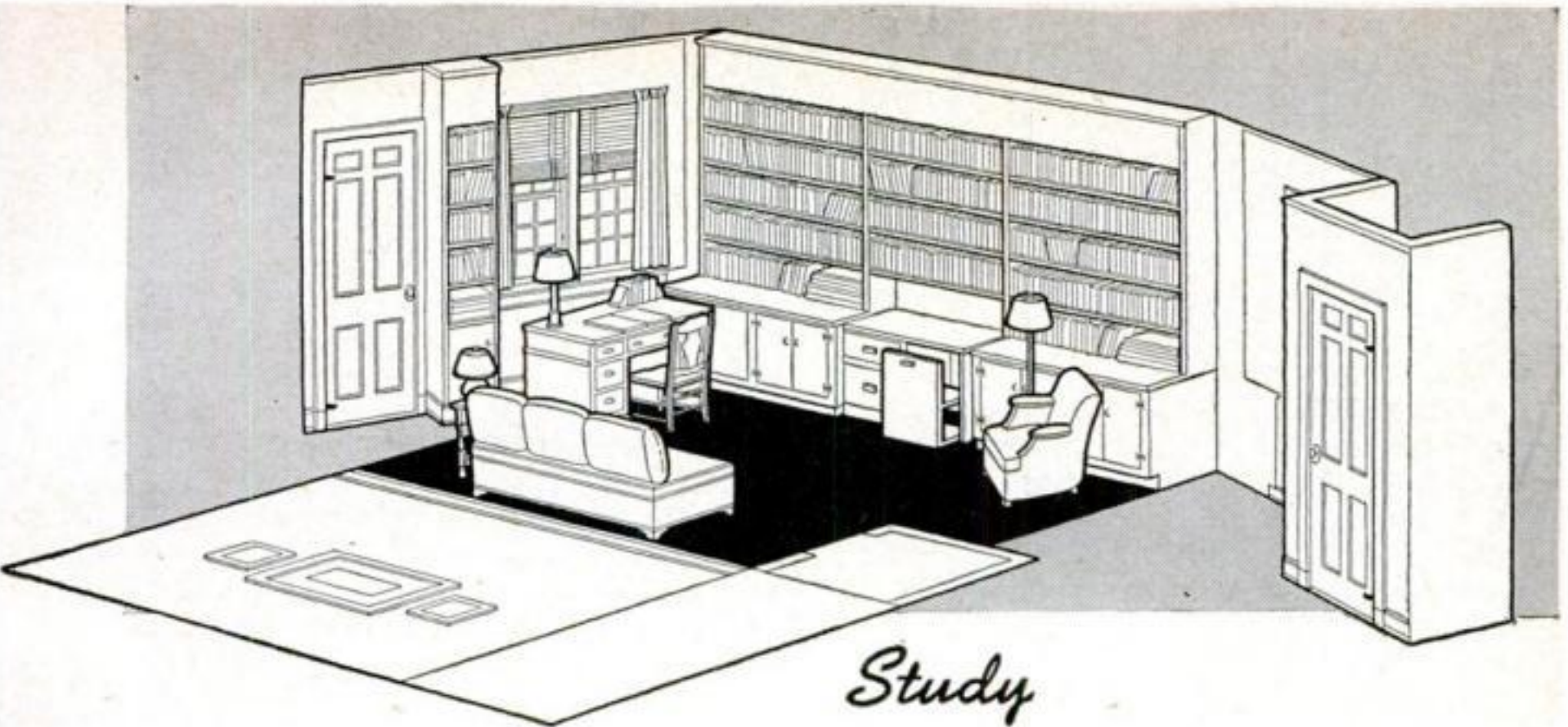
Chimney. The brick chimney will have head and cross joints filled full and smooth and be lined with fire-resistant clay flue linings. It reaches 5' above the roof, and the flue linings are to extend at least 6"

above the top. Built into the fireplace area will be a cast-iron damper and an ash dump; at the bottom of the flue there will be cast-iron clean-out doors for furnace and fireplace. The base of the hearth will be concrete on a brick arch, with a layer of split fire brick laid flush with the floor.

Heating and gas. The heat will be direct warm air, thermostat-controlled; the fuel preferably gas or oil. The furnace will include a forced-air (blower-filter) unit to make smaller ducts and air-conditioning possible. Grille registers will be set in the walls at the baseboard—two vents in the living room, and one each in the others. Gas equipment will include a range, water heater, and Bunsen burner in the basement shop. The water heater will have automatic control, cork-jacket insulation, and 60-gal. tank.

Plumbing. Joints in soil pipe and liquid-bearing pipe will be caulked and soldered. Soil pipes will be wrapped in hair felt to deaden bathroom sounds, and asbestos air-cell insulation will be used to prevent pipes from freezing on outside walls. The piping will be copper for water supply and cast iron for waste and vents.





Study

Wiring. To be adequate for varying loads in each circuit, arranged for a maximum of 1,000 watts in each, with an individual circuit for the refrigerator. A cut-out cabinet in the kitchen containing a series of switches will eliminate fuses. Outlets will be spaced not further than 12' apart.

Kitchen. The sink will be of steel with baked-on enamel finish, equipped with a right-hand drain board, mixing spout, rinsing spray, and removable cup strainer. There are two full-size closets in the kitchen and another one halfway down the back stairs.

Laundry. The laundry equipment includes a two-compartment tub, drying lines, ironing board, washing machine, and electric plate for starch and boiling.

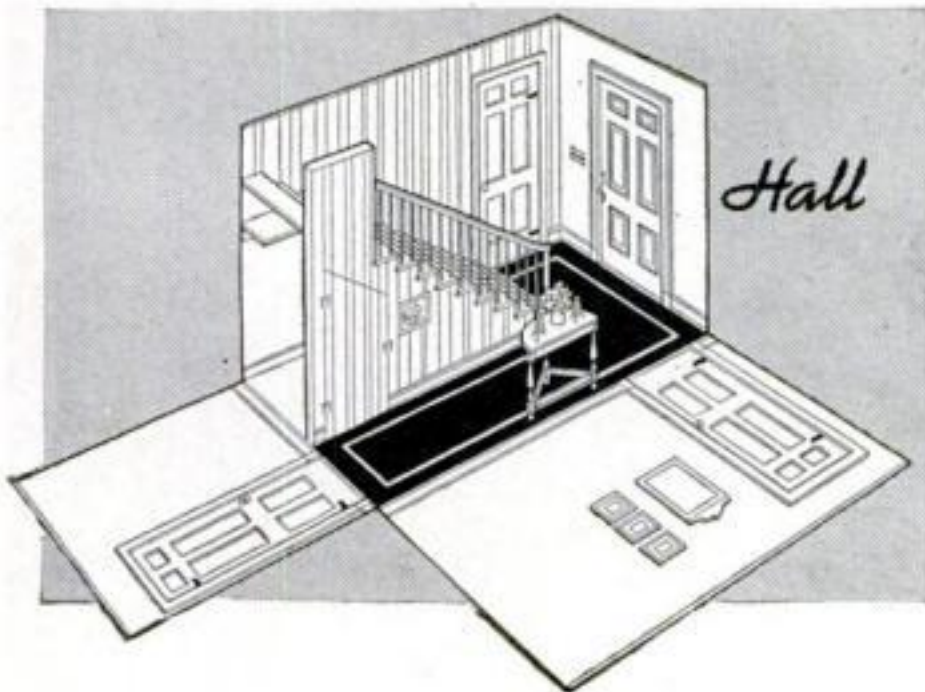
Shop. The shop and heater room is large enough for a good-sized workshop where we expect to spend much time. Our hobbies include furniture making, metal work, and model making. We already have some of the power tools—a metal-working lathe, drill press, circular saw, jig saw, forge and blower, and anvil. We have divided the shop into sections: for metal work, woodwork, and painting. The metal-work sec-

tion will have the forge and blower connected to the chimney flue above the furnace, and the anvil nearby. The drill press and lathe are conveniently near for both metal and woodwork. There are metal and wood-working benches, each with its wall cabinets for tools; paint bench and cupboards for keeping paints, cleaners, and brushes; and lumber rack and storage bin for new lumber, scraps, and partially completed projects.

We are using POPULAR SCIENCE'S idea in placing the jointer on the same stand with the saw. The stand, however, will be on casters that may be lowered by means of a lever to facilitate moving the saw about the shop. The jig saw is nearby. Outlets and lights will be placed near each power unit and bench. A master switch will cut out all power tools, and will be out of reach of children in a locked wall box.

Hardware. The exterior and garage doors will have accessories of bronze. The identification sign and lamp, as well as hinges and latches on fence and trellis, will be barffed (rustproofed) hand-wrought iron. Interior-door and fireplace accessories will be wrought iron. Light switches will be mirror backed, and the side lights in the dining room will be mirrored. The kitchen and game-room hardware will be chromium, as will the bathroom fixtures.

Finishes. With the exception of the shutters, all the exterior painting will be white—one coat of white lead and two of white lead and oil-pigment paint. The shutters will have three coats of oil-pigment paint, preferably navy blue. The interior birch will be treated with white lead, wiped off, and finished with a coat of wax. The walls, three weeks after plastering is hand dry, will receive one coat of good glue size and one of pastel calcimine.



Third-Prize Winners

SUBMITTED 20 DRAWINGS, WROTE 6,000 WORDS

GEORGE AND MARGARET MALLORY, of Evanston, Ill., were the only husband-and-wife team to win a top prize in the \$1,000 POPULAR SCIENCE home-planning contest. Even before they were married, three years ago, this young couple began planning details of the house they hoped to own. By the time the competition was announced, their prize-winning design was already pretty well planned on paper.

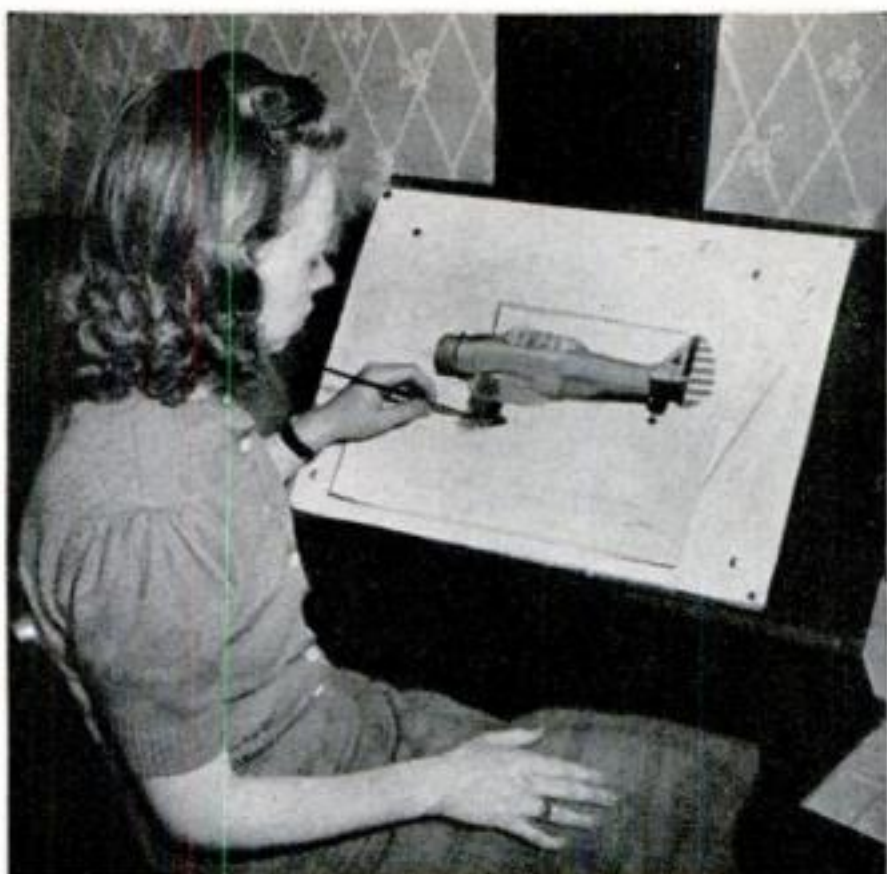
In the collaboration, Mallory did the floor

plans and his wife worked out the room designs and the final drawings. Their entry, of extraordinary completeness, consisted of 20 drawings, 11 of them in color, and a detailed typewritten description of about 6,000 words.

Art and mechanical-drawing courses, taken in high school, helped them in working up the plans. Last winter Mrs. Mallory attended a night course in metal work so as to prepare herself for making decorative hardware for the house they plan to build.



Mr. and Mrs. Mallory with their 18-months-old daughter Margaret. The Mallory entry was the joint work of husband and wife. He concentrated on the floor plans; she prepared the interior designs



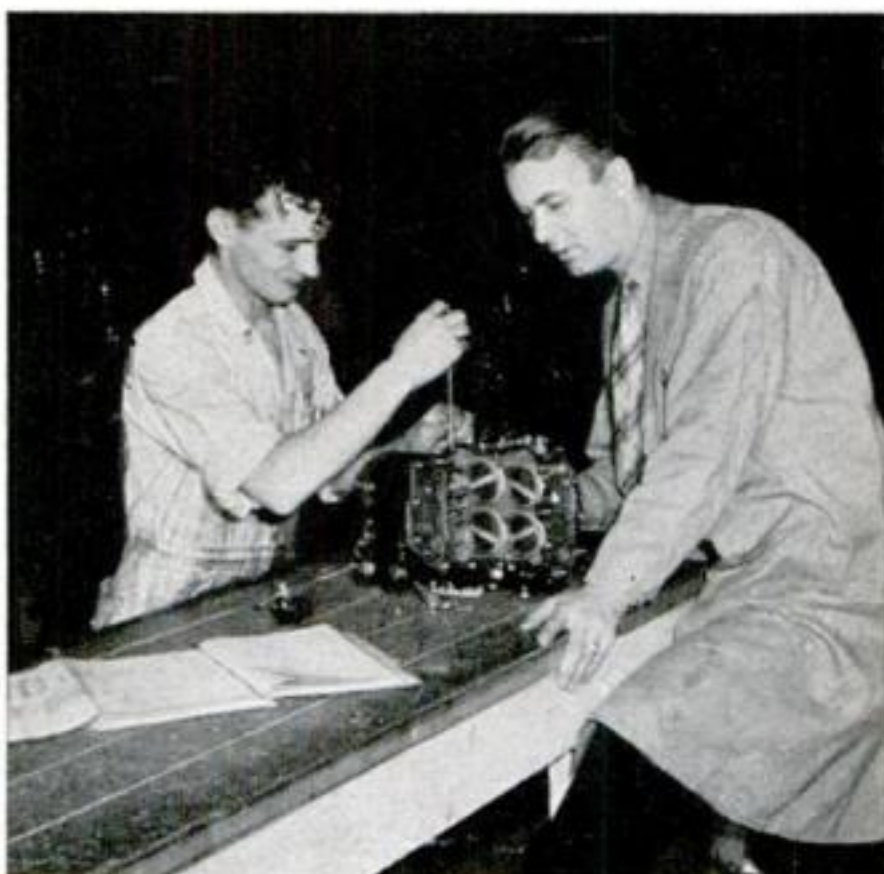
Painting airplanes is the hobby of Mrs. Mallory. Always fond of drawing, she studied interior decoration at Evanston High School and Smith College

Even before her marriage, Mrs. Mallory had her heart set on a Cape Cod house. She and her husband will build in Amherst, Mass., his home town



From the beginning the Mallorys were certain they wanted a Cape Cod style house. The downstairs, featuring a large living room and fireplace, presented little difficulty. The upstairs, however, had to be designed over and over again before they were satisfied. The final changes in the house were placing a study at the back and adding a workshop to the furnace room. Mallory's hobby is making model airplanes; Mrs. Mallory's is painting water colors of aircraft in flight.

Last June, Mallory was graduated from a Chicago aeronautical school as a licensed plane and motor mechanic. During the time



During the period of the contest, Mallory (left) was studying in a Chicago aeronautical school. He is now a mechanic at Wright Field, Dayton, Ohio

Mallory's enthusiasm for aviation extends even to models. To pay for his aeronautical course, he worked in an express office from 6 p.m. to 2 a.m.



he was helping finish up the house plans, he attended the school during the day and worked from 6 p.m. to 2 a.m. in an express office. Week-ends he devoted to the plans. His wife worked up the final drawings in the evenings after their 18-months-old daughter was in bed. All told, the Mallorys spent the evenings and week-ends of more than two months polishing the details of their design. They have a building lot picked out in Amherst, Mass., his boyhood home, where they hope the house will someday arise. And the POPULAR SCIENCE prize money has already been tucked away in a bank account marked "Building Fund."



FIG. 2

At top of this page, colored stripes on a false door panel, framed with evergreen roping through which lights are strung. Directly above, window decorations cut from colored cellulose material make a bright display by night, when the indoor lights are on. At right, the charm of a traditional post lantern may be enhanced by a spray of balsam trimmed with lights

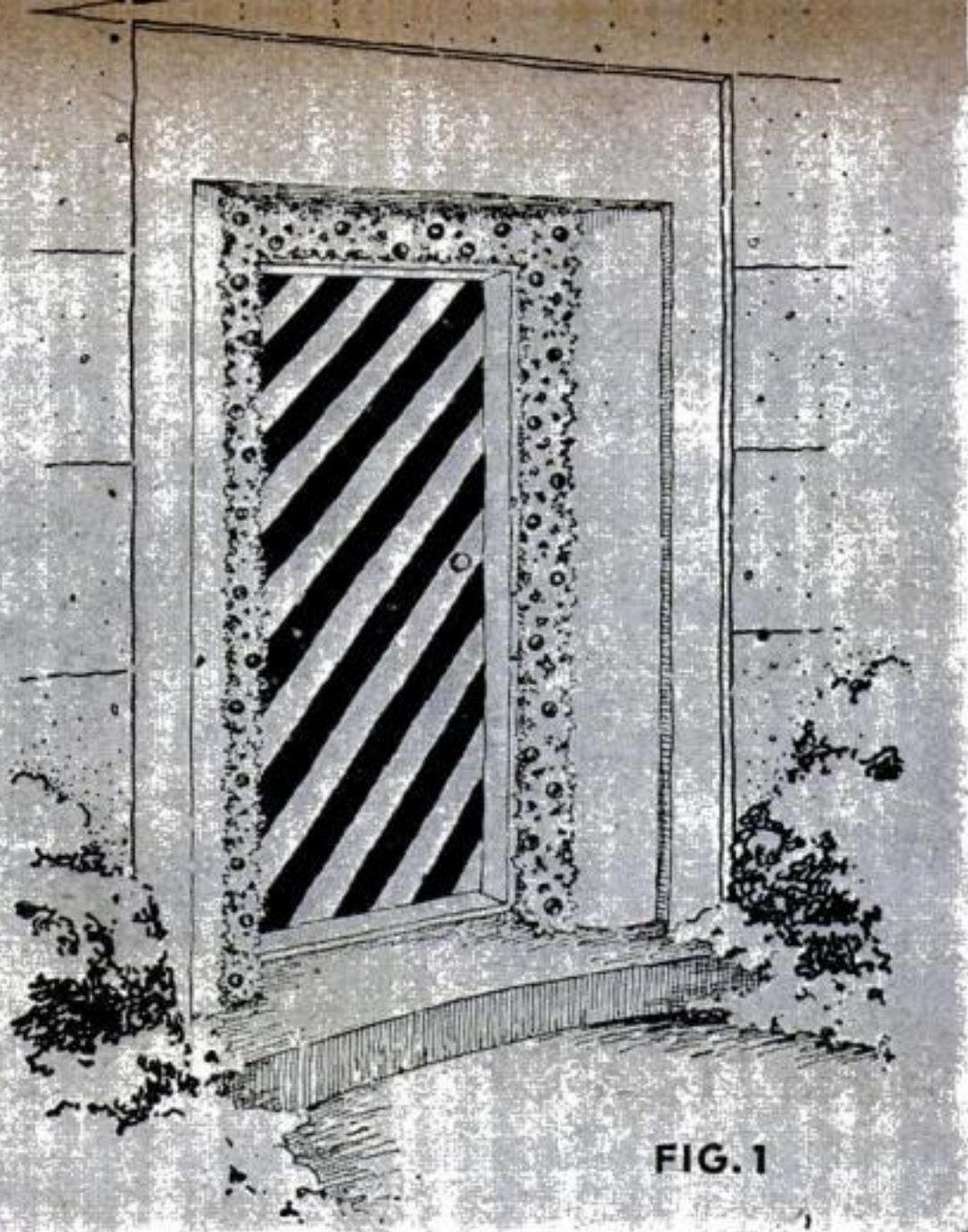


FIG. 1

Huletide

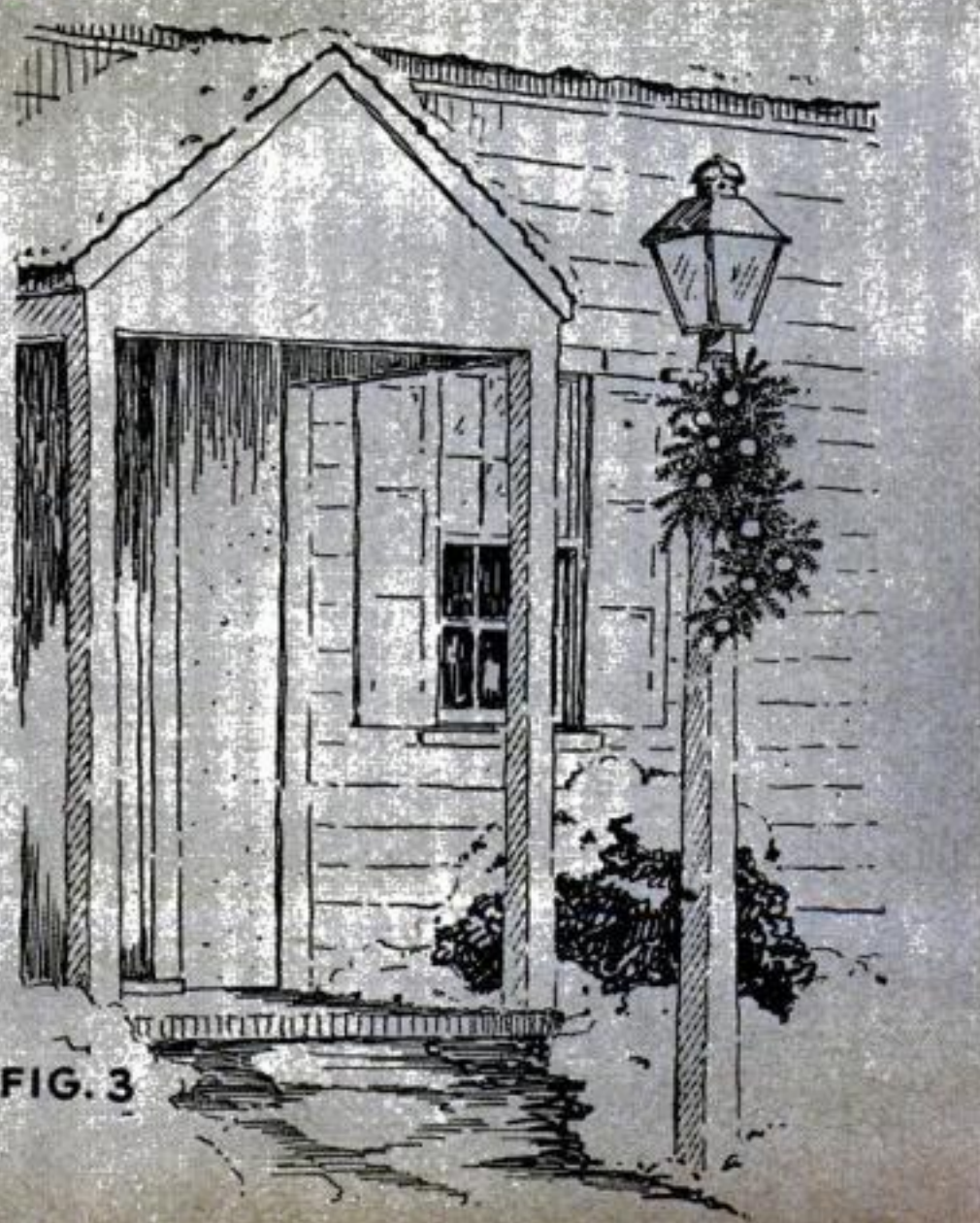
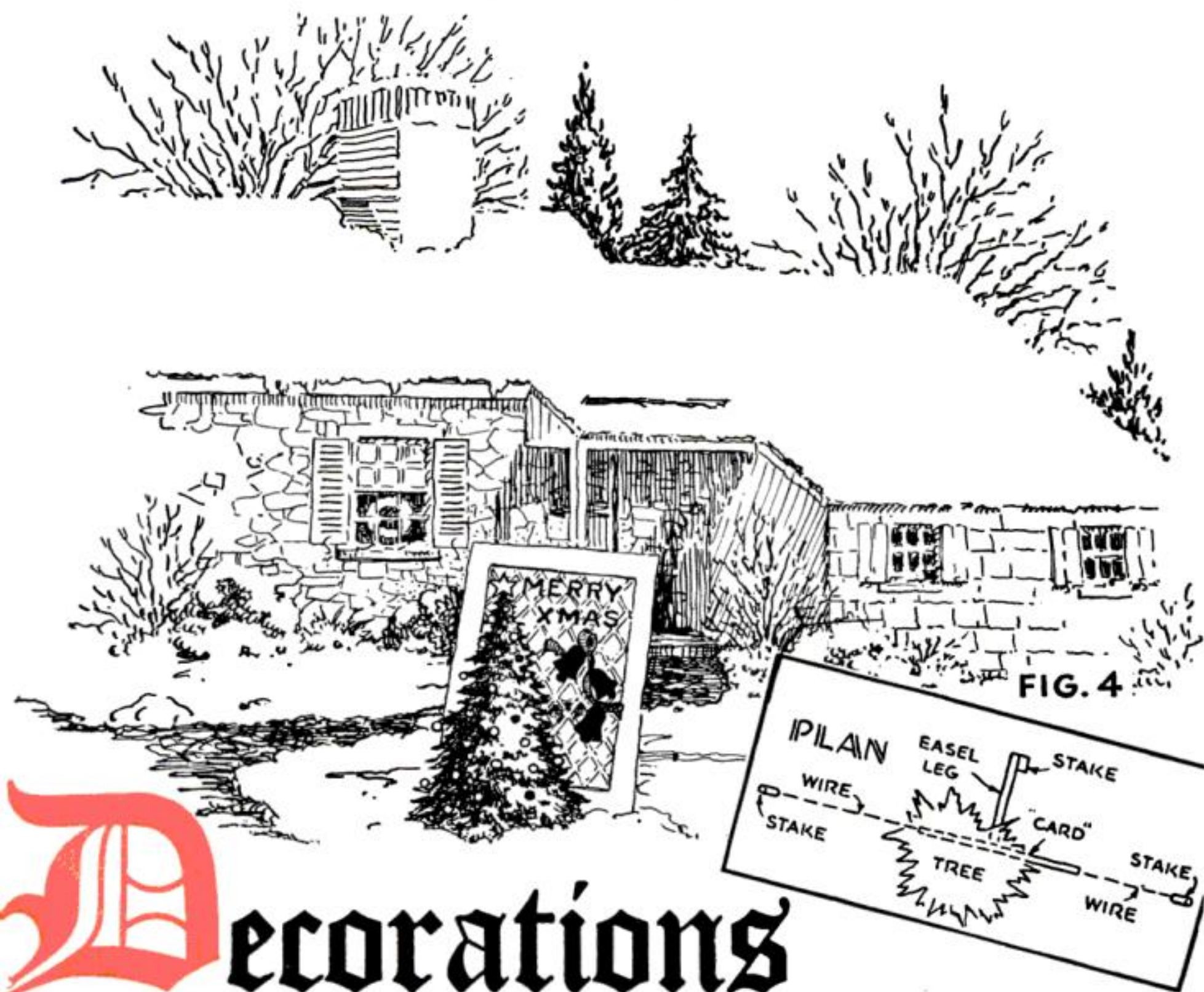


FIG. 3



Decorations

MAKE YOUR HOME SAY "MERRY CHRISTMAS"

By HENRY B. AUL

NOW is the time to begin planning something different in Christmas decorations for your house and lawn or garden. The usual multi-colored string of lights and illuminated tree are always pleasing, but perhaps your home possesses architectural features, landscaping, or other characteristics that will lend themselves to a more unusual—and distinctive—treatment. On these pages POPULAR SCIENCE offers a few suggestions that may enable you to make the most of such advantages.

Some home owners paint their doors an appropriate color for the holiday season. If you hesitate to do this, why not fasten a false front of heavy cardboard or composition board to the door? It must, of course, be well fitted to allow the door to close properly. If there are raised moldings around the panels, you may have to insert narrow wood strips under the cardboard to obtain a good fit. Thin brads will hold these, as well as the false panel, in place. Cut holes over the latch, keyhole, and knocker, if any.

Thus prepared, a door offers all sorts of intriguing possibilities in the use of paint, lights, and greenery. Figure 1 illustrates a treatment consisting of 4" wide diagonal stripes of red and gold and a frame of evergreen roping studded with lights. Orange or orange and white lamps will intensify the red and gold of the door and enhance the decorative effect at night. Red lights, however, would deaden the green roping to a brownish tone.

Such a decorating scheme is especially adaptable to doors of modern design. Red and white, silver and blue, or white and gold stripes could be used. A door painted solid blue might be ornamented with silver stars of various sizes applied at random over its entire surface, and further set off with a bunch of foliage accented with tiny silver bells and fastened with a bow of silver ribbon. White floodlights would heighten the effect by night.

If your house has a white Colonial door, it can be strikingly but inexpensively decorated

with a single good-sized wreath fashioned of mixed greenery and cranberries, with one large cluster of shiny English walnuts and pine cones. Perhaps you can hang it on the door with a large red bow of ribbon. A concealed floodlight will make the effect even more striking by night than it is by day.

A novel window decoration is illustrated in Fig. 2. Candy canes, tree ornaments, bells, horns, holly leaves, and poinsettias are cut from colored cellulose wrapping material and fastened to the glass on the inside with rubber cement or bits of cellulose tape. At night the usual room illumination or a small floodlight makes these visible outdoors in full color. By day they show to advantage inside the room.

Post lanterns add a quaint holiday touch when placed beside the walk or near the porch. Usually they are fitted with a red, blue, or green lamp bulb, but their effect may be enhanced by tying underneath the lantern a spray of balsam through which runs a string of small colored lamps, as shown in Fig. 3.

Quite novel, but warm and friendly, is the use of a lighted outdoor tree as part of an outdoor greeting "card." This is illustrated in Fig. 4. The card is made of light boards and lattice strips, painted a bright bronze, gold, or silver. To it is attached the greeting "Merry Christmas," cut out of heavy cardboard or thin plywood and painted a contrasting color.

Mount the card slightly to one side of the tree, pulling the rearmost branches through the latticework so that tree and card appear to be almost in the same plane. Nail the bottom of the frame to stakes driven in the ground, and run light guy wires sideways

from each upper corner to other stakes as shown. A few of the lights at the back of the tree are fitted with tin reflectors to illuminate the card more brilliantly.

The size of the frame will depend upon that of the tree, but it should probably be no more than 6' or 7' high. If twin trees are used to flank a gateway or other entrance, one may proclaim "Merry Christmas" and the other "Happy New Year."

Candles are ever-popular decorating motifs, although for safety and convenience the electric candle has replaced the wax taper almost universally. One can be used in each window, or several can be arranged to form a pyramid of light. Mailing tubes or pieces of stovepipe can be fitted with sockets and set into flowerpots, dish pans or more elaborate holders as lawn and porch ornaments. Very effective also is the single candle placed inside a cottage-type window and flanked by tie-back curtains.

If your door has side lights, you can display vertical rows of electric candles as shown in Fig. 5. These may be placed upon small square shelves fastened to a 1" by 3" upright, which in turn is fastened to the inside wall or door frame so as to be invisible through the side lights. Similar improvised shelves might support candles behind the lights of a transom or in diagonal, vertical, or crossed formations in large windows.

Window boxes can be transformed into decorative high lights. Small trees planted in them may be trimmed with tiny lamps or may conceal banks of colored floodlights that illuminate a decorated window. In the latter case the silhouetted trees will be pierced with an attractive fretwork of light.

Woven evergreen mats of various shapes, studded with lights, are very effective for trimming bare expanses of wall. A framework of 1" by 2" lumber, covered with light, large-mesh chicken wire, serves as a foundation. Weave in or tie to it balsam branches or small green twigs to make a mat of any desired thickness. Trees, stars, bells and other simple shapes are best. The lamps may be placed to emphasize the contour of the piece, or scattered over the surface. Figure 6 shows an evergreen mat made in the shape of a tree and fastened against a large house chimney. Another good location is between windows. Furthermore, if you have always wanted to trim a big outdoor tree, you can make one in this way as large as you please, and deco-



Electric candles mounted behind transom or door lights on invisible shelves strike a mellow Yuletide note. They can also be used in various formations behind large windows

FIG. 6



rate it with all the globes and other ornament usually used. Your ingenuity is the only limit to what can be accomplished by this method.

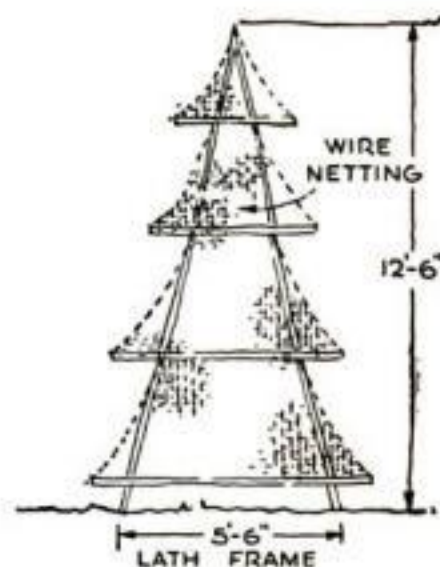
However, outdoor trees will this year probably again reveal a trend toward carefully worked out lighting effects in two or three colors only.

Lamps may be placed in such a way that colors blend slowly into one another. Green, red, or blue may be used around the lower portion, for example, a few white lamps introduced at the middle, and the proportion of these increased until the lighting at the top consists entirely of white, with perhaps a white star at the tip of the tree. Dramatic effects can be worked out in this way by the blending of one color into another.

In choosing colors, remember that green light makes foliage appear still greener, but red lamps darken it to a brownish tone. Orange and yellow lamps lend a mellow touch, and white ones contribute a bright sparkle that accents all other colors. Blue lamps produce a cold and often somber effect. For the traditional tree of many cheerful lights, simply mix all available colors.

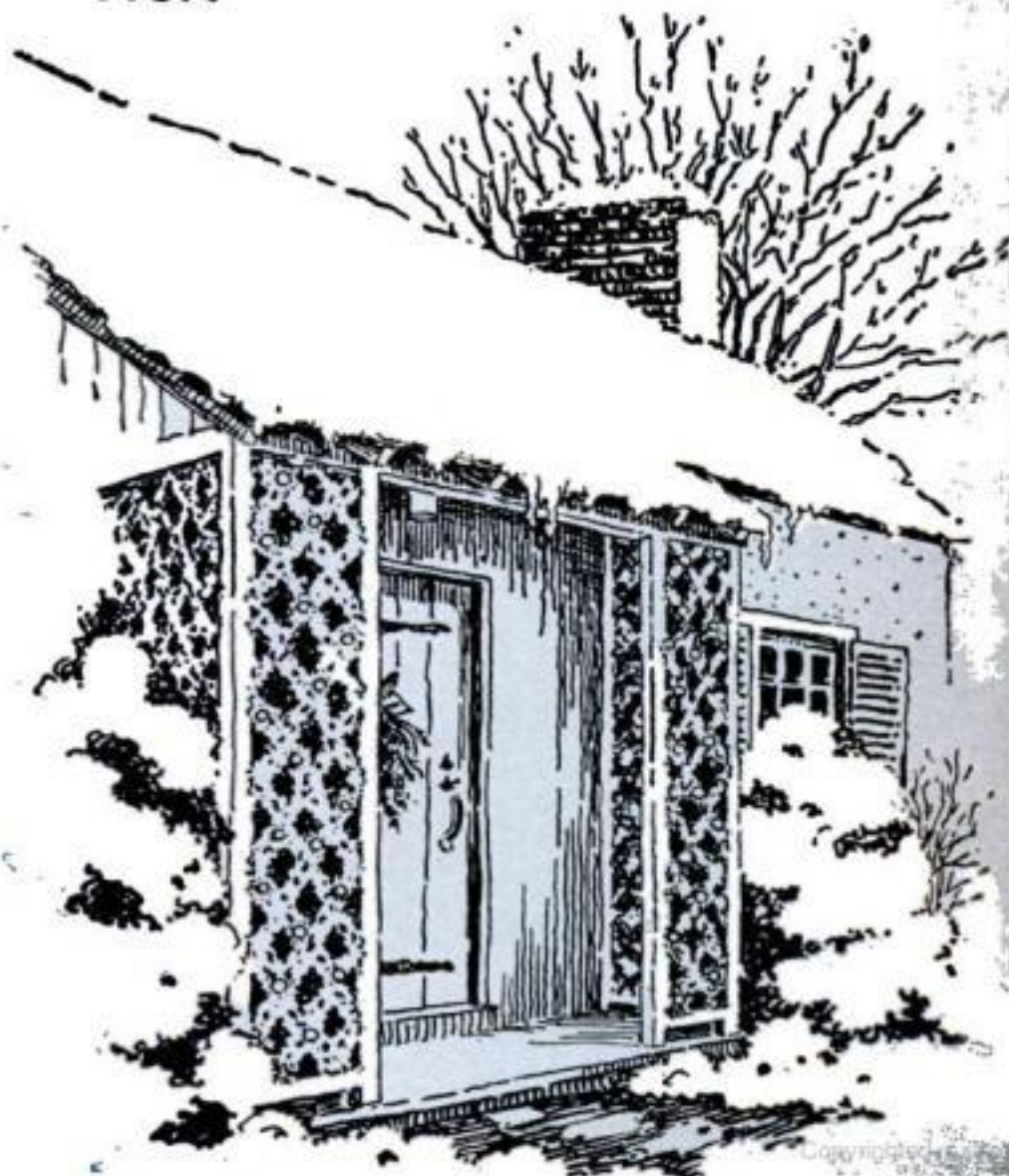
Increasingly popular is the idea of decorating latticework around doorways, porches, or fences close to the house with strings of lights. Although the nighttime effect of this is pleasing, little or none of it remains by day. To overcome this defect, first cover the latticework with evergreen roping (Fig. 7), then secure the lamps to this. Star-shaped tin-foil reflectors can be used, if desired, to accentuate the lamps.

Make your own tree to order, as big as you please! Wire netting on a lath framework as shown at the right forms a support for balsam twigs



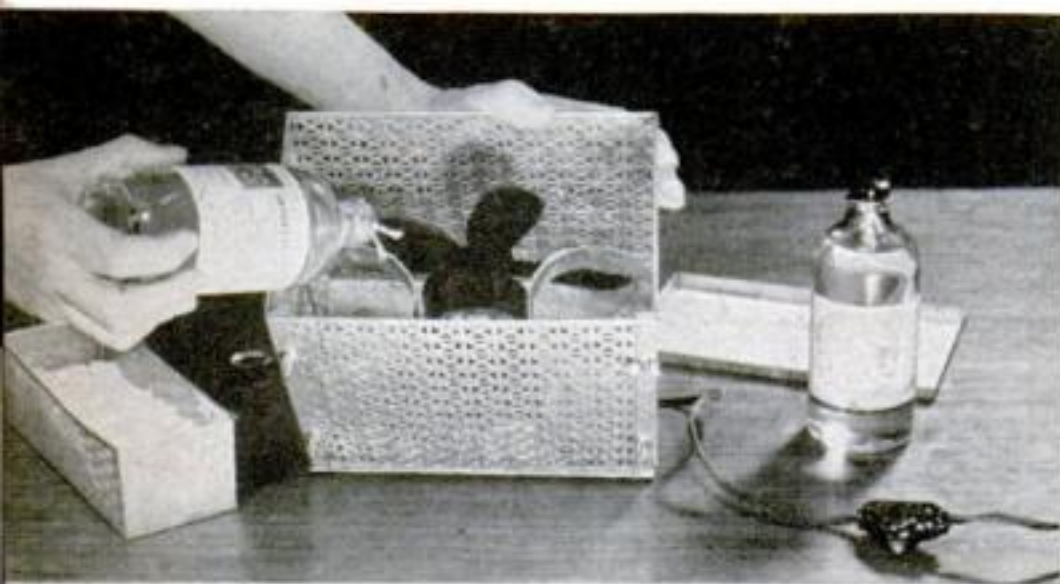
Below, latticework trimmed with colored lights on evergreen roping is decorative by day as well as by night

FIG. 7

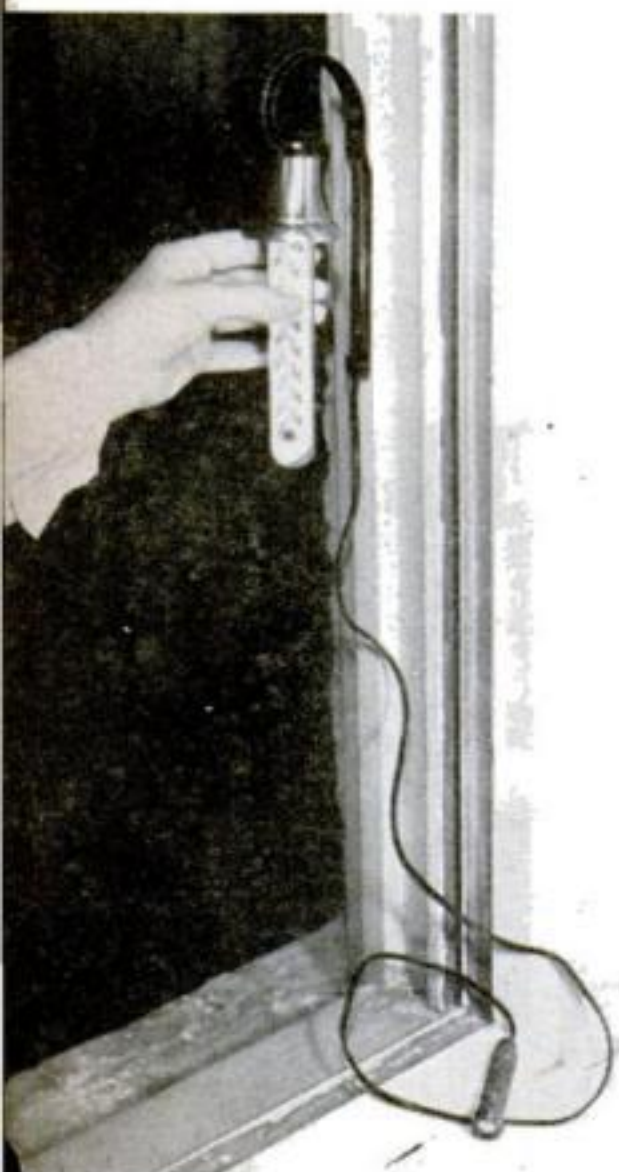


IDEAS for HOME OWNERS

WEEDING BECOMES A GAME with a non-back-breaking weeder that has been put on the market. Stick the prongs on the end of the rod into the weed, twist, pull, and up comes weed and root. Point towards the garden basket, press the trigger in the handle, and shoot. The weed will travel some 8'. Six prongs grab the weed when a disk that holds them apart slides up on a spring as the weeder is pressed against the ground. Mechanism in the rod releases the disk, ejecting the weed, at a pull on the trigger.



MOSQUITOES OR MOTHS are killed, or a kitchen deodorized, through the use of the basket and fan device shown at the left. In demoting a closet, a container fitting in the top is filled with crystal flakes of a standard moth repellent, and the air from the built-in fan circulates through them. The door of the closet should be closed for the best results. The mosquito-repelling and deodorizing fluids are in bottles which have wicks passing through their corks. Either or both are inverted, and the air current circulates the vapors.



ILLUMINATION FOR AN OUTSIDE THERMOMETER, shown at left, is provided by an attached battery flashlight controlled by a cord and push button. The thermometer and flashlight are attached to the outside window casing with two screws. The cord runs under the closed sash.

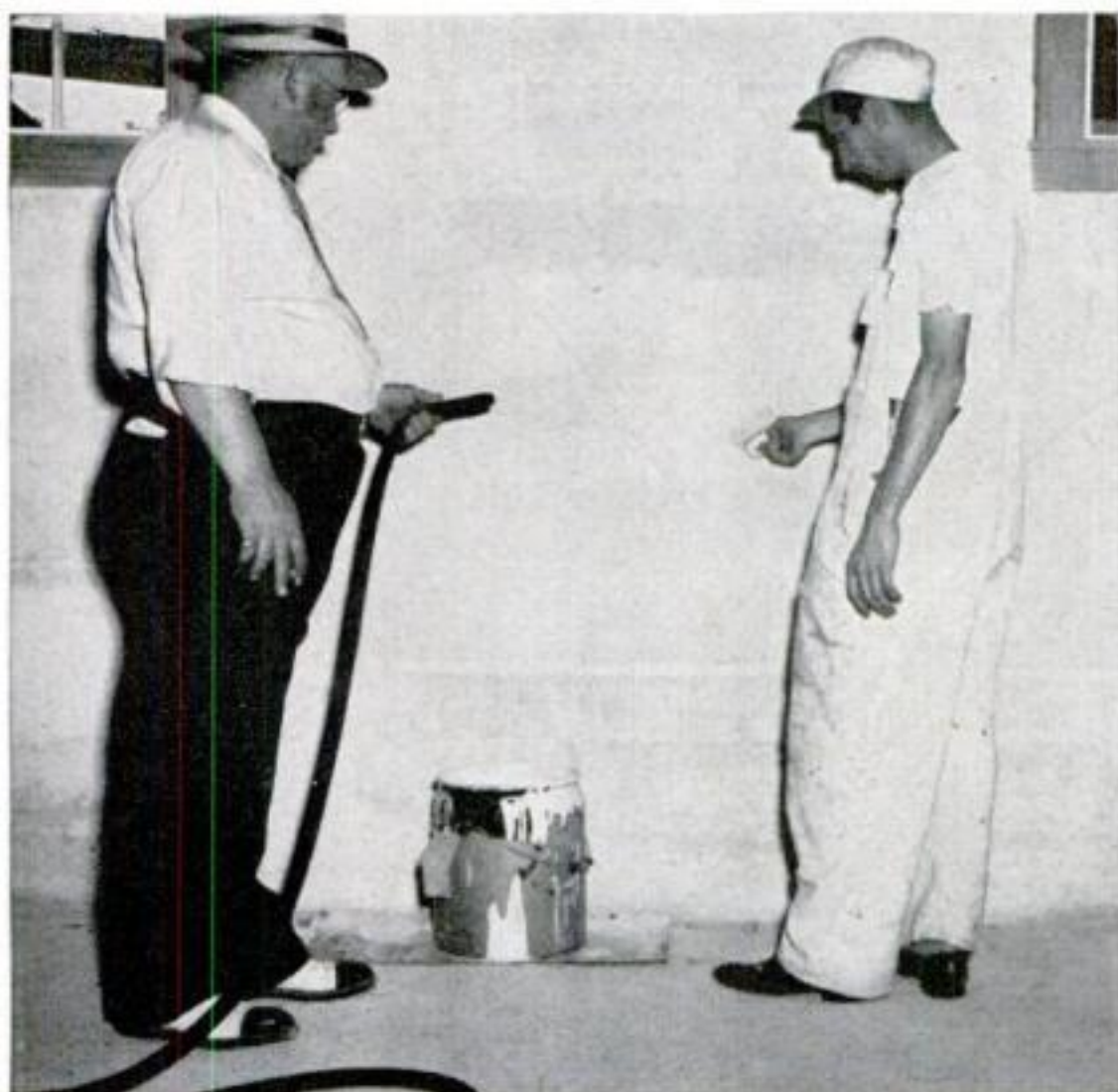
THIS FLEXIBLE KNIFE for filling joints between plaster boards, tile boards, and other wall boards, has a 4" blade with a square trowel edge. It is oil-hardened and tempered tool steel, and will bend to a point about 1 1/4" from the edge. The tang goes through the handle to the tip, and the handle is attached permanently with four brass compression rivets. An oversize alloy bolster prevents water and plaster from creeping under the handle.



CONCRETE REPAIRING is simplified with a ready-mixed patching material that eliminates the necessity of chipping the old surface. The area to be repaired should be cleaned with a wire brush, and a little of the material scratched in with a trowel as it comes from the container. Then it is brought to the desired level and smoothed. For crevices deeper than $\frac{1}{2}$ ", it should be applied in layers, and each layer allowed to dry partially. Complete drying takes from 2 to 12 hours. Basement floors can be damp-proofed by using a primer and then covering them to a thickness of $\frac{1}{8}$ " with the cement.

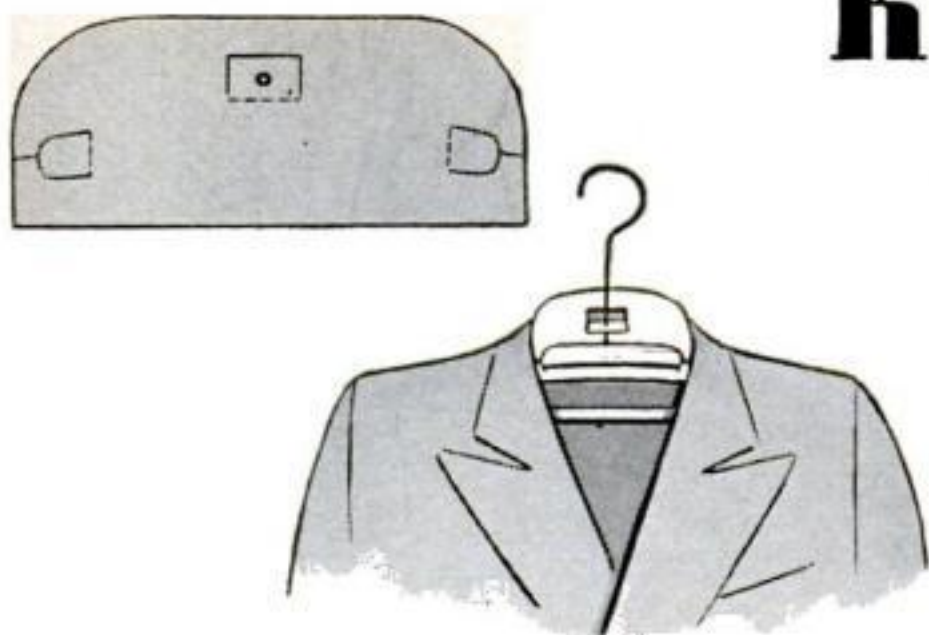


REFINISHING A GLOSSY SURFACE without sanding is possible with a new liquid which removes dirt, grease, and wax, deadens the gloss, and leaves the old finish slightly tacky, thus providing a base on which the new finish will bond readily. It is especially convenient for surfaces such as moldings where grooves and other spots hard to sand are numerous. It is not a paint remover and contains no chemicals that will harm the hands.

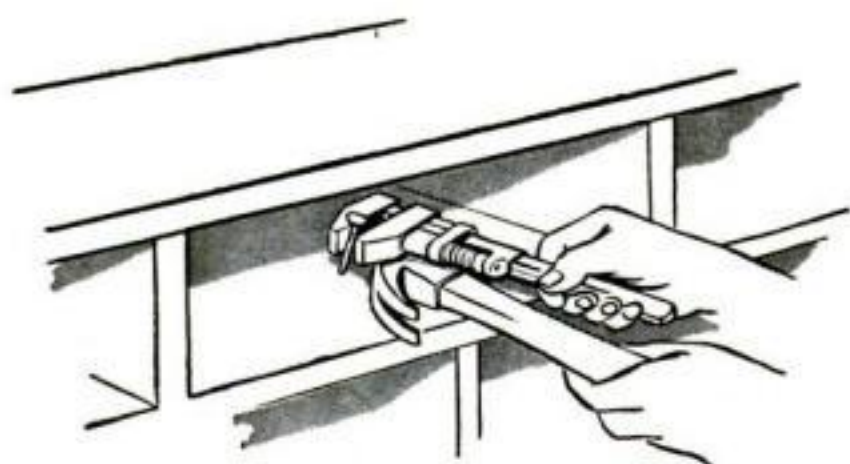


OIL PAINT THAT "BREATHES" is used now for painting over new plaster and masonry where formerly, because of the lime or alkali present, time for thorough drying was necessary to prevent deterioration of the finish. This new paint does not seal in the moisture, but allows the plaster to dry out after the finish has been applied. It is said by the manufacturer that finishing can be done the day after plastering, and that the paint itself will dry in about an hour. Once it is dry, it can safely be washed. The paint can also be used over calcimine or whitewash without taking the time and trouble to remove the old finish. Interior and exterior mixtures are available.

KEEPING THE



Ordinary hangers usually let garments slip sideways, and fail to support the collars properly. A 3" by 6" piece of stiff cardboard shaped as above will keep a hanger centered and prevent sagging of a coat collar. Slip the middle tab over the hook



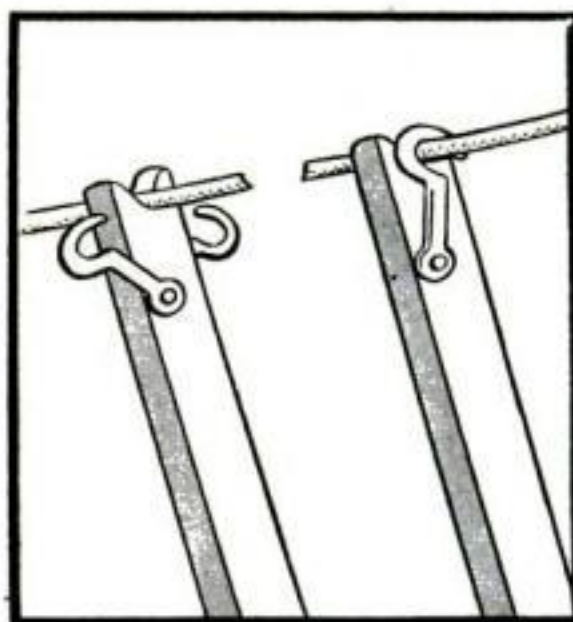
Where space is too cramped to permit using a claw hammer to pull out nails, this can often be done by means of a monkey wrench as shown above. The hammer is used as a fulcrum. Close the wrench jaws under the nailhead, then bear down on the handle



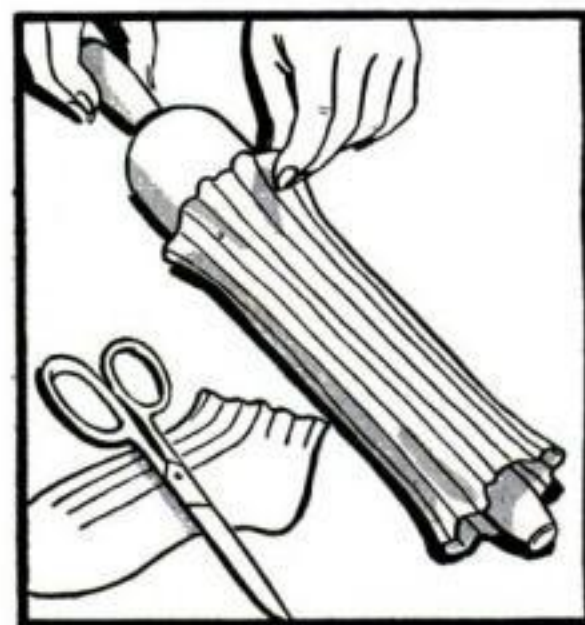
If a vacuum cleaner or attachments for cleaning upholstered furniture are not available, the work can be done with a cloth dipped in clean water and wrung out. Place this over the fabric and tap it gently all over with a flat board. Dust comes to the surface but cannot escape into the air. Wipe off with the cloth, repeating as necessary



Crisscrossed strips of adhesive tape on the bottoms of ash trays will prevent marring of table tops or other polished surfaces



A clothesline pole cannot fall over if fitted with two 2" oval brass hooks as shown. Facing in opposite directions, these hold the pole securely to the line

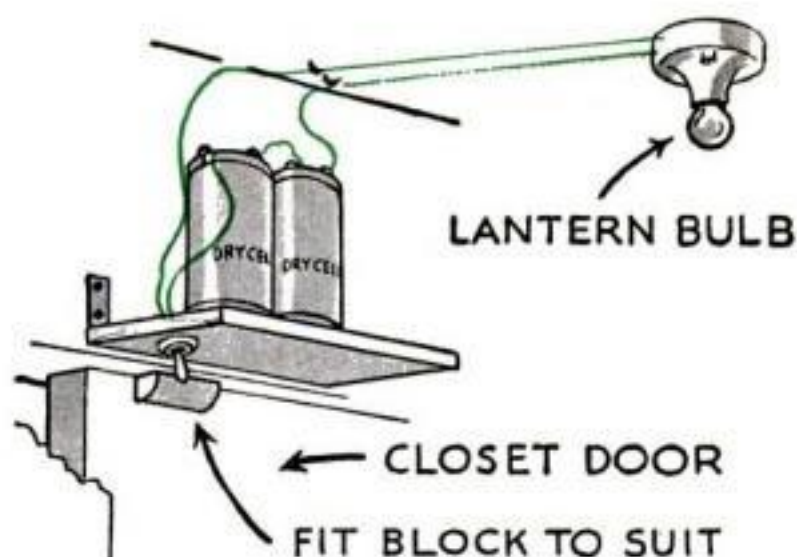


Time is saved in rolling out dough by slipping the leg of a new cotton stocking over the rolling pin, which then requires only one sprinkling of flour instead of several

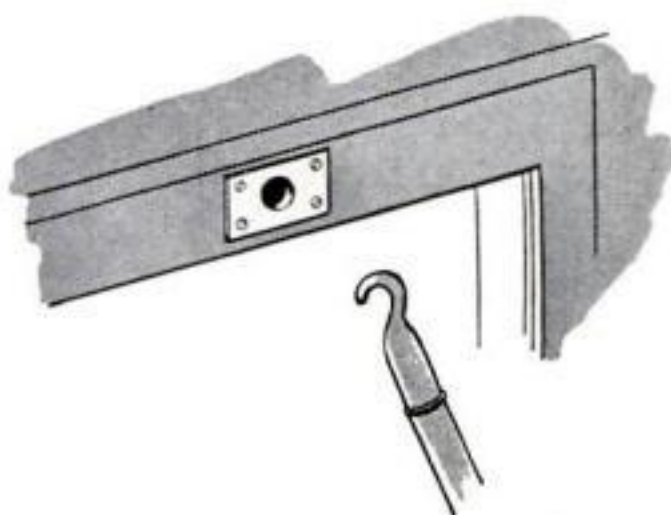
HOME SHIPSHAPE



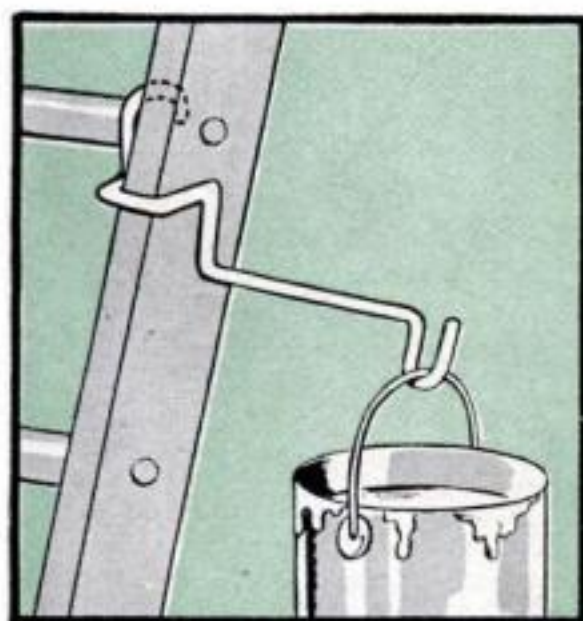
The necessary sizing of walls and ceilings preliminary to papering them can be done by applying the solution with an ordinary household sprayer such as is shown above. This method is speedier than using a brush, produces a more even coating, and causes less dripping on floors and baseboards. An orchard or garden sprayer could also be used



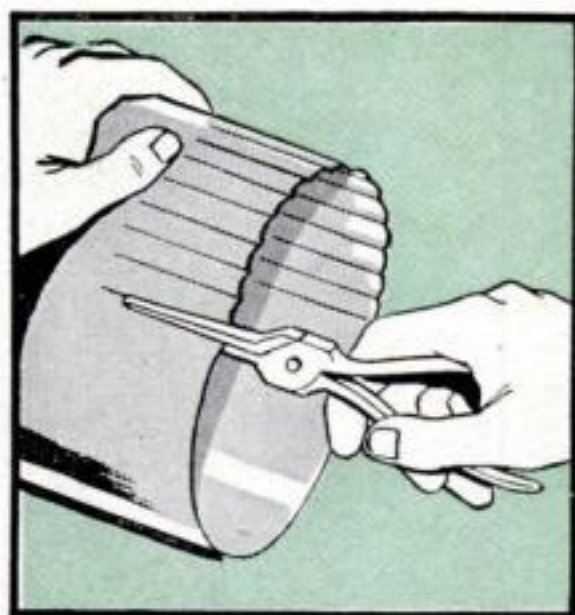
You can fit a dark closet with a simple semiautomatic light by mounting a radio toggle switch on a shelf inside the closet as shown. Use two No. 6 dry cells and a large 2.4-volt bulb of the type sold for electric lanterns. The switch is turned on by hand, but snaps off when the door is closed



School and office windows are often broken because the window-pole sockets cannot be seen against the glare of outdoor light. Painting the socket plates white makes them visible against dark sash frames even on very bright days. Do not paint the sockets



A paint-pail holder to hook over round ladder rungs is made by bending a 21" length of $\frac{1}{4}$ " iron rod to the shape shown. For light cans, you can use an old curtain rod



To make the cut end of a piece of stovepipe fit into another, grasp the edge with long-nosed pliers and twist slightly. The crimps should be evenly spaced



If the encrusted cap of a glue can is pressed on in an inverted position, fresh glue will flow down and form an air-tight seal

Two Craftwork Novelties

DESIGNED BY JUAN OLIVER



VAQUERO PENHOLDER. A South American *vaquero* on a balky horse provides the amusing decorative motif of this useful penholder. The piece can be made

in about three hours

and is an excellent gift project. Band-saw horse and rider together from $\frac{3}{4}$ " thick mahogany or other hardwood. With a knife or carving chisel, cut back the wood to outline the various parts as indicated.

Bevel the mane of the horse and taper the tail toward the body. Shallow holes represent the animal's eyes. Drill other holes on each side of the face and in the *vaquero's* hands to receive the reins, which are short pieces of $\frac{1}{16}$ " brass or bronze rod. Sand or file the hind feet flat for mounting at the correct angle.

Saw the base from $\frac{5}{8}$ " stock to the smooth, irregular contour shown. The edges may be beveled or left flat. Use $\frac{1}{2}$ " ma-

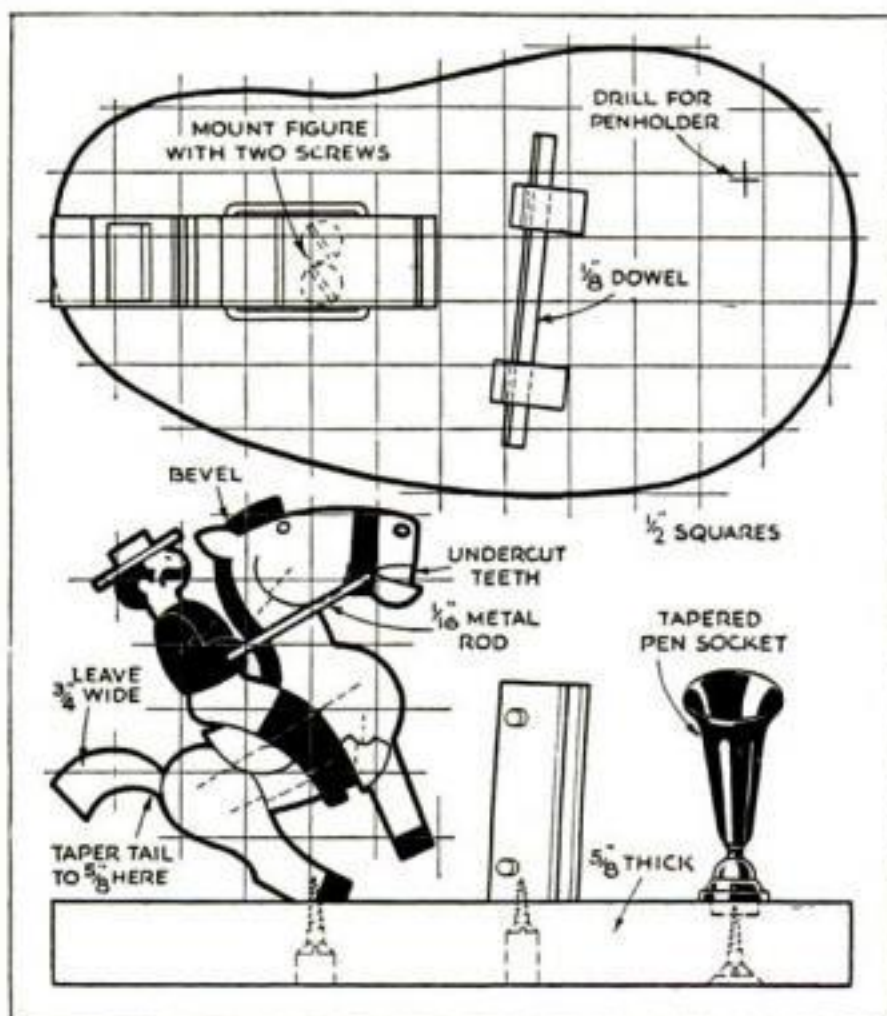
terial for fence posts, and $\frac{1}{8}$ " dowel for the rails.

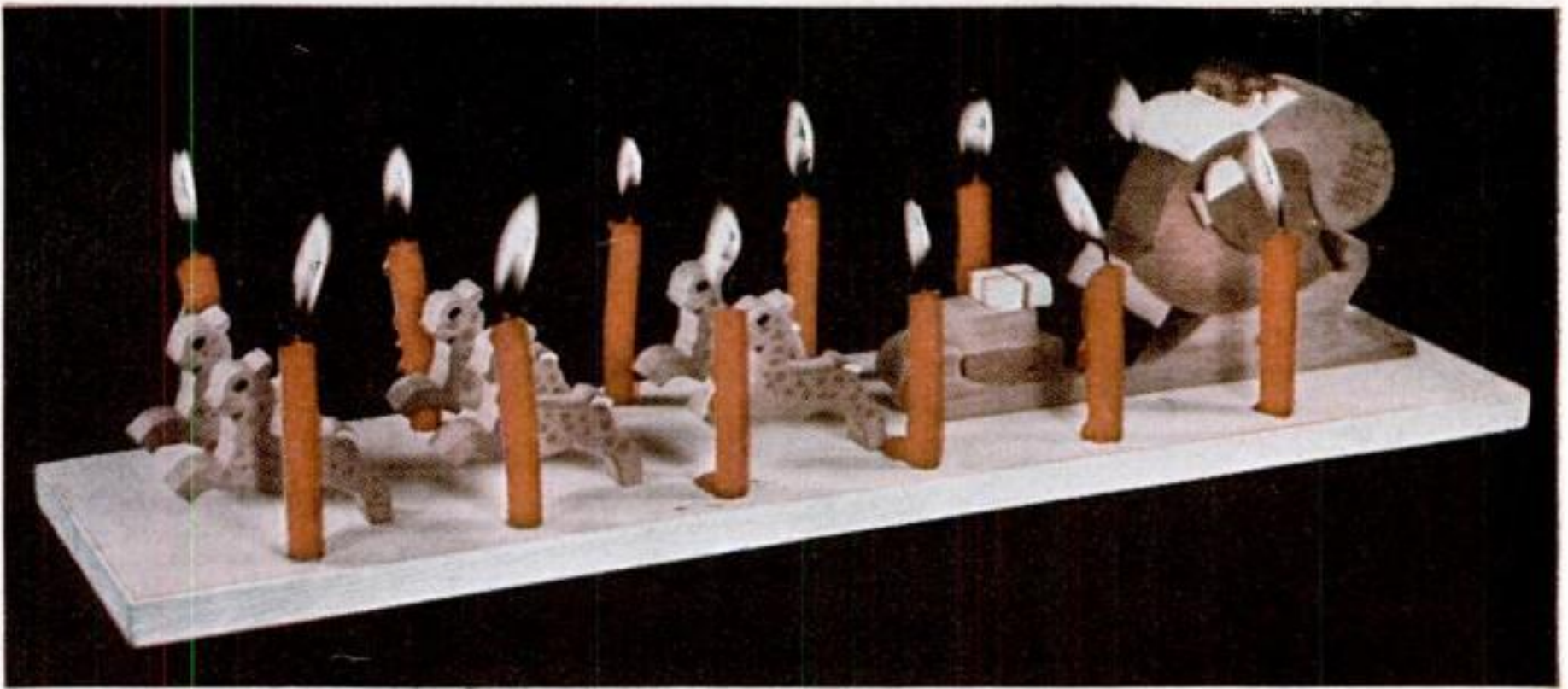
After sanding smooth, give all parts two thin coats of shellac. If desired, this may be rubbed down with fine abrasive paper and waxed. Accent the mane, bridle, nostrils, and hoofs, as well as the *vaquero's* shirt, trousers, and face, with flat black paint. Use white to set off the horse's teeth and forehead, the stirrups, and the cowboy's hat.

Fasten all parts to the base with countersunk wood screws. The pen socket, which may be taken from a discarded desk set or purchased new for a small sum, is mounted by means of a single machine screw.

SANTA CLAUS CENTERPIECE. Cleverly stylized little deer and a simplified figure of jolly old Santa Claus on a loaded sled, flanked by twelve miniature candles, comprise this attractive Christmas centerpiece for dining table or mantelpiece. Construction is for the most part simple scroll- or band-saw work, although the carving may be carried out more elaborately if the maker wishes.

By means of squares, draw the profile of the sled and figure on 1" mahogany or other closely grained wood. The boxes piled on





Flaming candles, a jolly Santa Claus, and stylized deer add this Christmas touch to the table or mantel

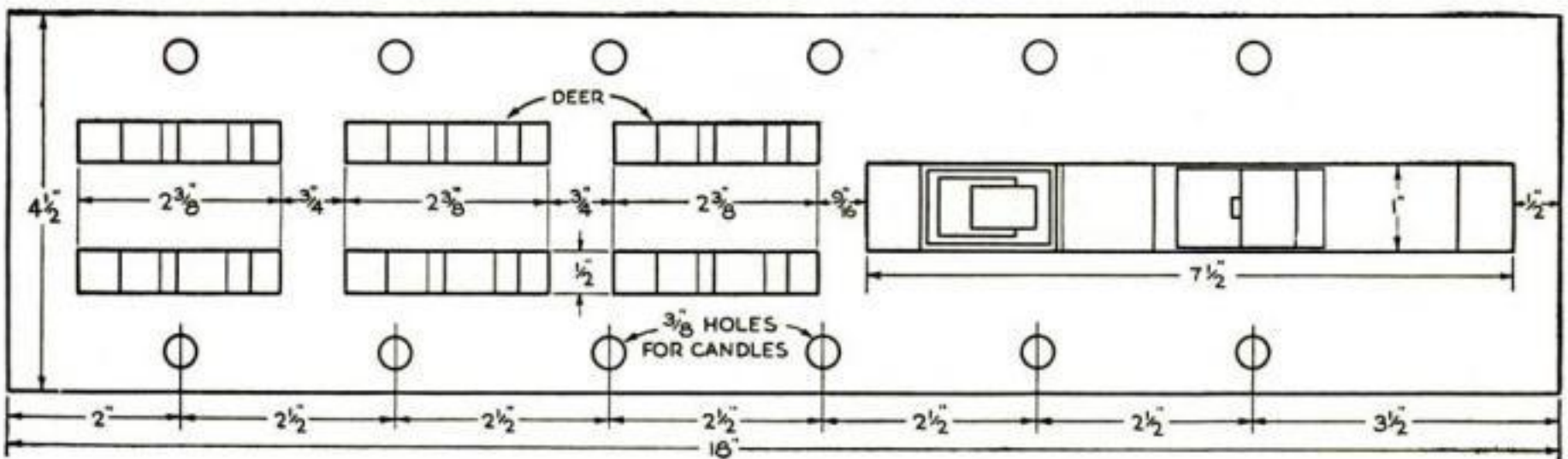
the sled can be cut out from the same piece, or may be simple blocks glued on separately. Note the space under the heel through which the band-saw blade may enter to cut the inner line of the leg, coat, and seat.

The various offsets marked on the drawing can be undercut with a sharp knife or wood-carving tools. Cut only far enough back to produce the desired effect. Saw the six deer from $\frac{1}{2}$ " material. These require no carving of any kind if carefully sawed to shape.

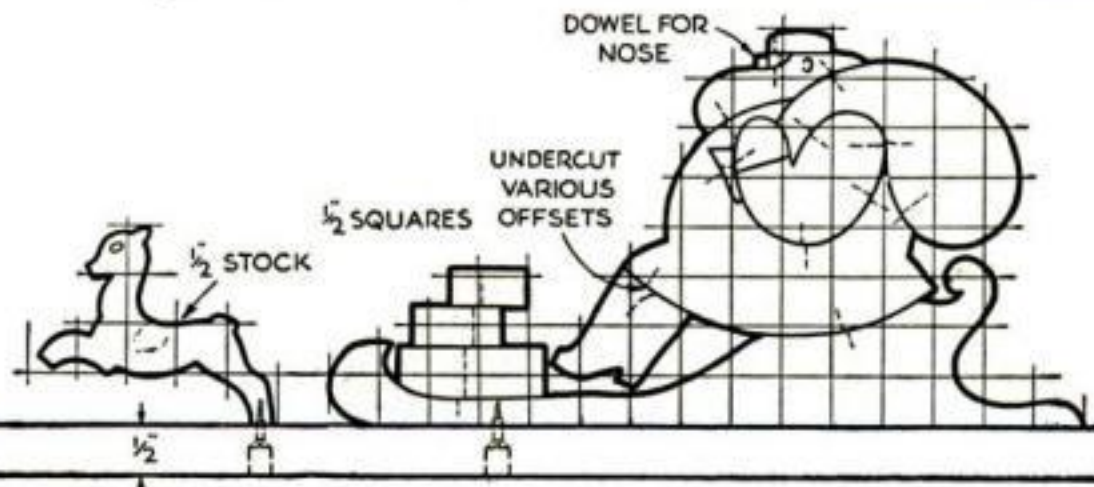
In a $\frac{1}{2}$ " by $4\frac{1}{2}$ " by 18" baseboard drill twelve evenly spaced $\frac{3}{8}$ " holes for candles. Paint this base with flat Japan color or egg-shell enamel. White was used for the origi-

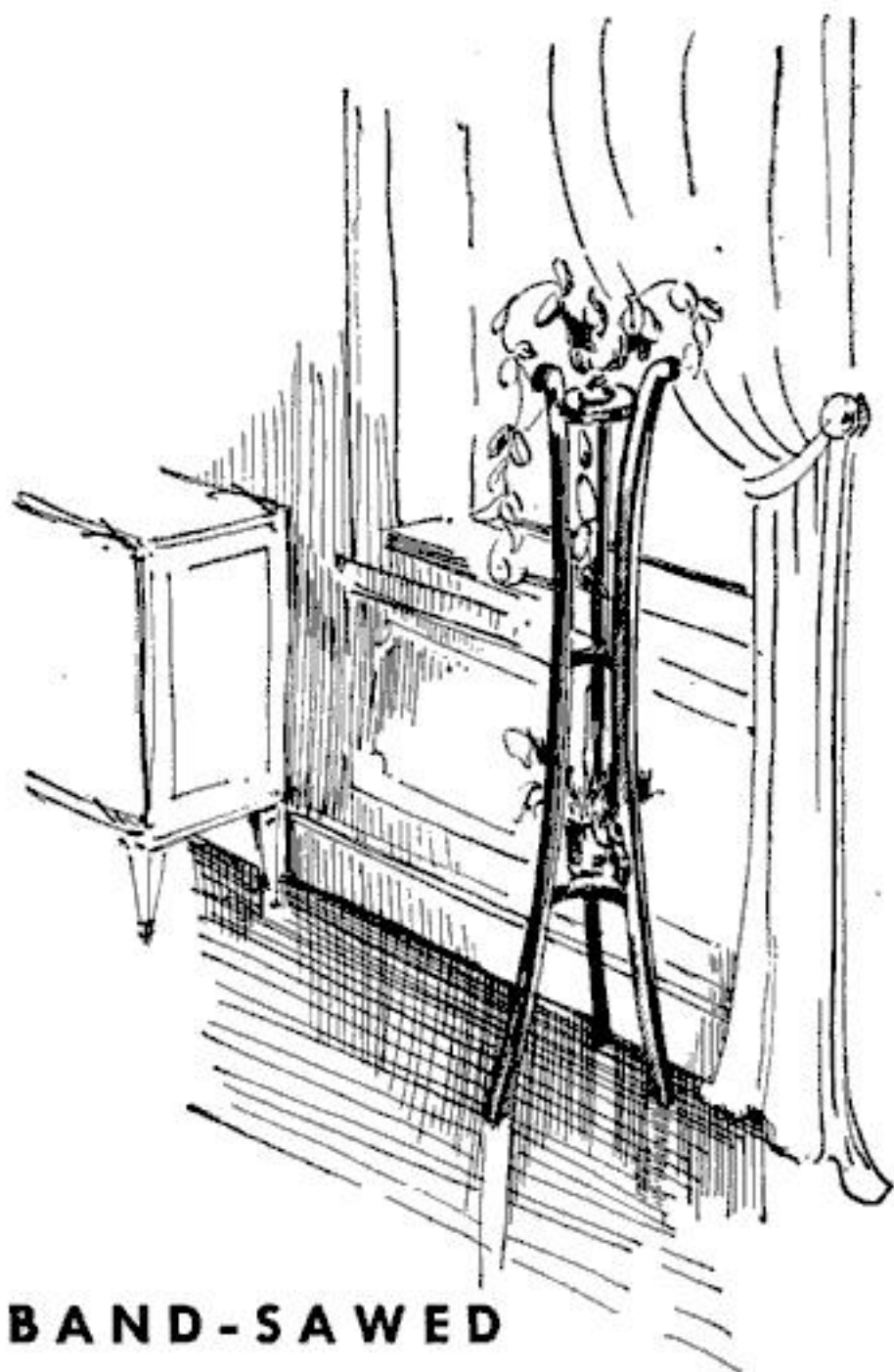
nal, as well as for Santa Claus's beard, hair, and hands. The topmost of the three packages also was painted white, with crossed red stripes to represent ribbon wrapping. Use black for Santa's boots and for the eyes of the deer, marking the tails of the latter with a touch of white. Shellac or varnish may be used to accent parts of the figure and to produce tawny little spots on the deer.

The remaining parts may well be left the natural color of the wood, as in the original. If desired, narrow ribbon traces can be strung between the animals and led back to the front of the sled, but do not let these hang where the candles may set them afire.



Careful sawing will eliminate the necessity for much carving, though there must be some offset work on the Santa Claus and sled. White, black, and red paint, and varnish or shellac, will complete the job





BAND-SAWED

Flower Stand

IN REGENCY STYLE

RARE is the home that has not some spot where flowers or a living plant may be displayed to advantage. If a stand is used for the purpose, however, it should be unobtrusive. The simple, dignified lines of this design, reminiscent of the Regency style that happens to be in popular favor at the present time, also make it an easy piece to build, even for beginners.

For a natural finish, mahogany would be a suitable material, but less expensive woods will serve. You will need one piece $\frac{7}{8}$ " by 10" by 42" to band-saw the legs from, one turned or sawed disk $\frac{7}{8}$ " by $5\frac{1}{2}$ " in diameter, and two pieces of the same thickness $3\frac{3}{4}$ " and $5\frac{3}{4}$ " square respectively. While the legs can be cut with the least waste from a piece 10" wide, as suggested, narrower stock will, of course, serve just as well.

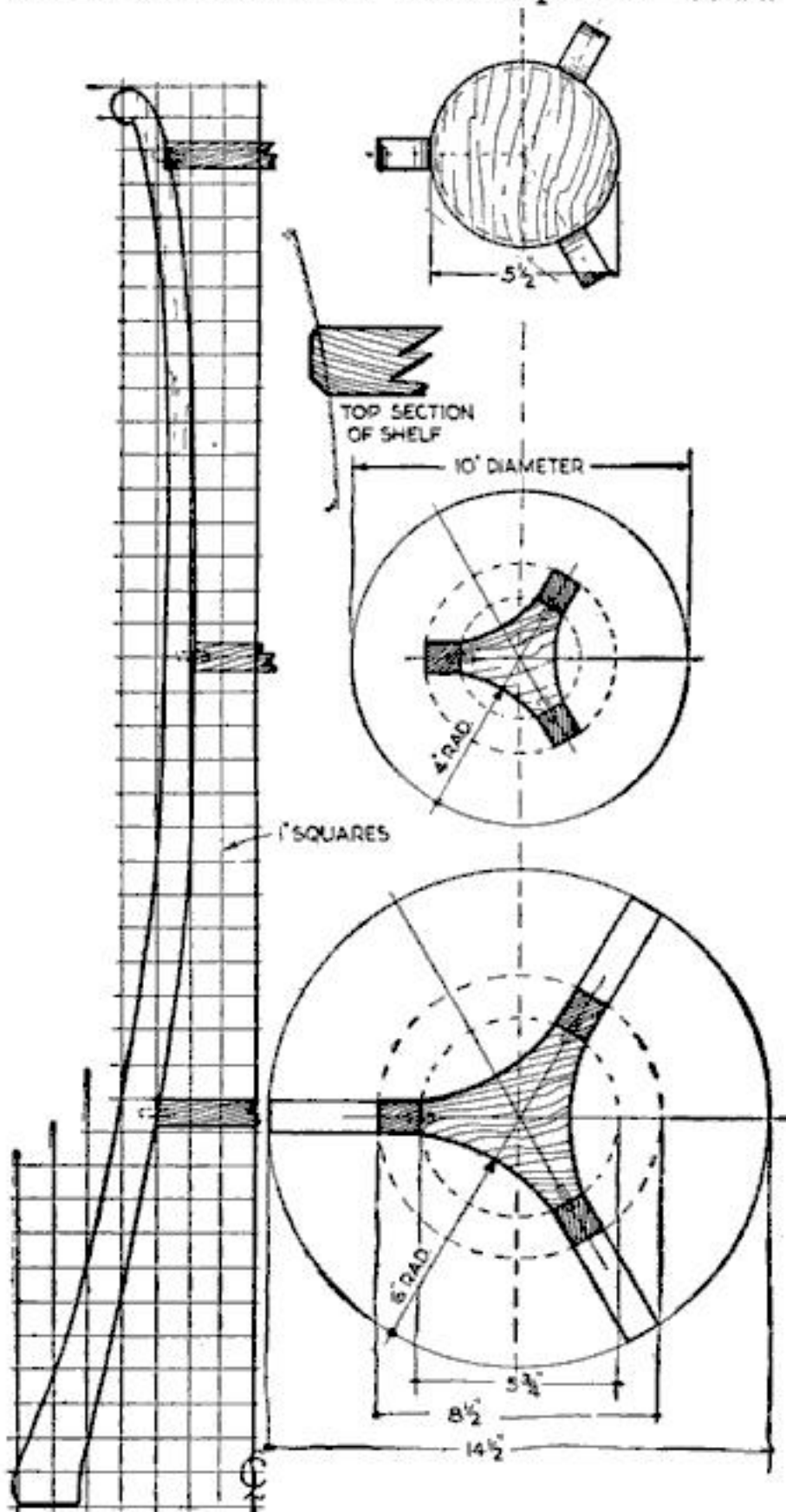
Lay out the legs by means of squares, saw them out, and round off the edges. The patterns for the middle and bottom shelves are laid out by means of compass curves. If desired, the under edges of all three shelves may be beveled about $\frac{1}{4}$ ". Cut shallow dados into the legs and glue in the shelves with

A Great Furniture Designer Offers to Help You

THROUGH POPULAR SCIENCE you have at your service one of the foremost modern furniture designers—Joseph Aronson of New York. If there is any special piece of furniture you would like him to design, he will gladly include the plans in his present series of articles, provided, of course, that the project is of a type to interest a reasonable number of other readers. Write him in care of the Home and Workshop Department.

a single dowel pin to strengthen each joint.

It is also compatible with modern style to paint such pieces as this. Typical colors are black, off-white, dark green, or light gray. A fine gold stripe along the edges of the legs, if expertly applied, enhances the effect. Pairs of stands are being used in symmetrically balanced rooms to support candelabra or ornaments as well as plants.—J. A.



Handsaws

AND HOW TO USE THEM

At right, ripping a long board. Your position should allow you to see both sides of the saw in order to follow the line accurately. Below, ripping a short board on a bevel. Move the work forward gradually to avoid cutting the support

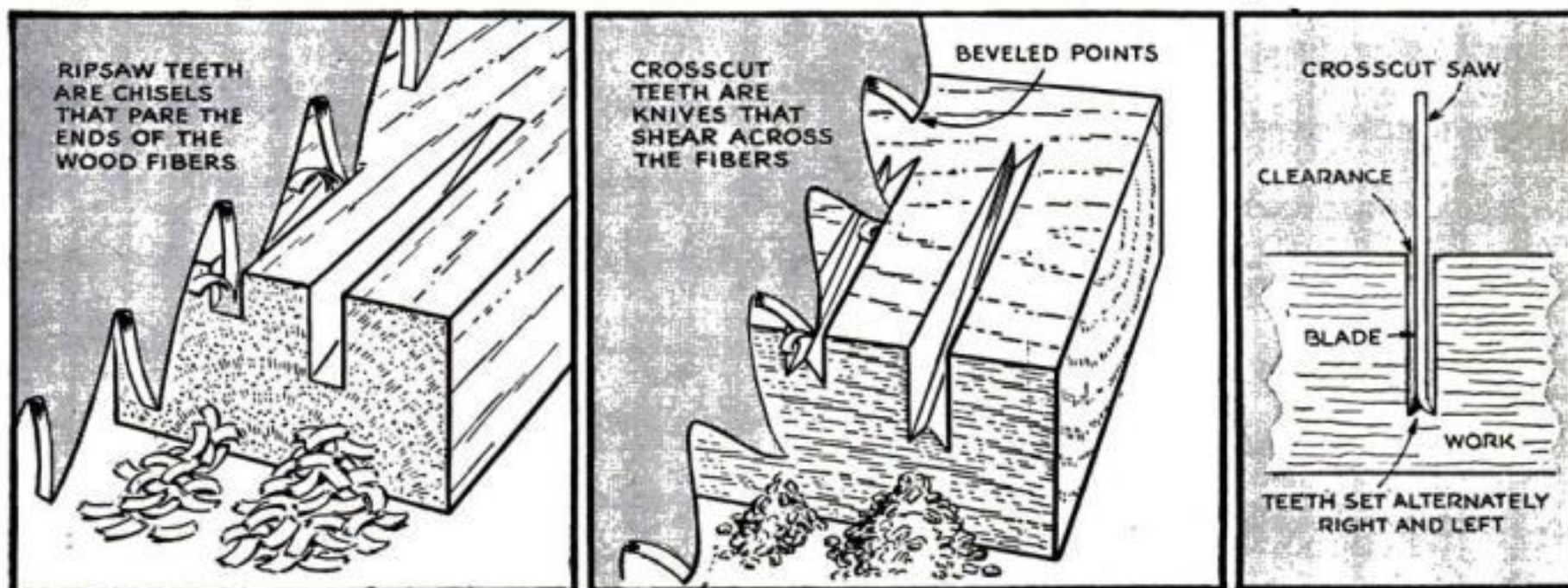


By EDWIN M. LOVE



MACHINES, versatile though they are, can never displace hand tools altogether in even a well-equipped workshop. Large or oddly shaped work sometimes cannot be handled on a machine. Pieces partially assembled may have to be completed by hand, and, of course, much jobbing and carpentry work is done outside the workshop with limited equipment. Some skill in the use of hand tools is therefore requisite. Of all such tools, handsaws are among the most useful, and the mastery of them will not only afford the craftsman a great deal of satisfaction, but will also give him added confidence to meet any special problem that may arise. If good

Fig. 1. How rip saw and crosscut teeth work. Both are set to cut a kerf wide enough to clear the blade



handsaws are added to the tool kit from time to time as the need for them arises, and properly cared for, they will invariably prove a wise investment.

What types of handsaws are needed?

CHIEFLY rip saws and crosscut saws, supplemented by the keyhole, compass, coping and turning saws for curved work, and by the backsaw and dovetail saw for joinery.

How do a rip saw and a crosscut saw differ?

IN EFFECT, the teeth of a rip saw constitute a row of chisels that slit a board lengthwise. A crosscut saw has teeth with inclined and beveled edges; these shear across the grain of the wood much like knives. Figure 1 illustrates both types of teeth, which are in both cases bent or "set" alternately to right and left, so that they will cut a kerf wider than the thickness of the saw blade. It will be seen that the bottom of a rip saw kerf is flat, but the kerf of a crosscut saw has a ridged bottom. The blade of a good saw is usually tapered in thickness from the toothed edge to the back for additional clearance, so that it will be less likely to bind in the kerf.

How is a rip saw used?

TO RIP a long board, lay it across two sawhorses and hold it down with the right knee, as shown in Fig. 2 and in one of the photographs. Grasp the saw handle with

the forefinger lying along one side. Place the other hand at the end of the board so that the thumb guides the saw blade at the start of the cut (Fig. 2). It is preferable to start with a down stroke of the blade, which thus immediately cuts a groove. Starting with an upstroke may cause the saw to jump from the mark. Continue sawing with steady, full-length strokes, being careful not to draw the blade back so far that it jumps from the kerf, as this may thrust it against the work elsewhere and possibly kink the blade. Do not force the saw at any time; little or no pressure beyond the weight of the blade is necessary for rapid cutting.

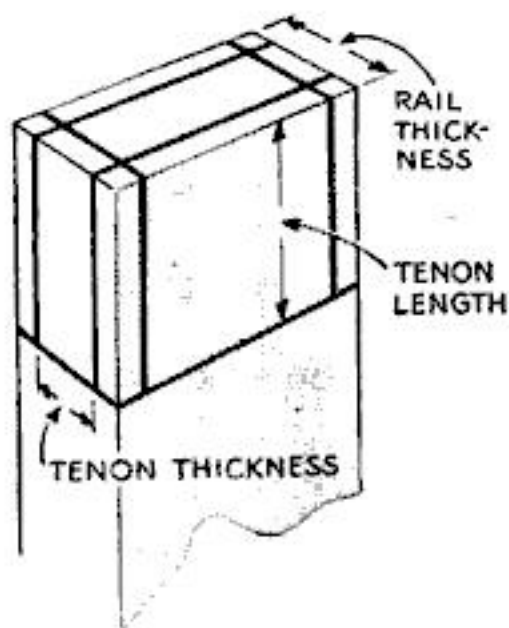
The right shoulder and elbow and the saw blade should lie in the same vertical plane, and your position should be such that you can see both sides of the saw. Practice will make this stance instinctive. The line of travel of the teeth should be about 45 deg. A stroke more closely approaching the vertical would cut across the fiber ends too abruptly, and cause excessive splintering at the bottom of the kerf; a more horizontal stroke would bring the teeth in contact with too large a cross section of the work and cause slow cutting. If the board is to be jointed, rip it from 1/32" to 1/16" outside the line to leave a little extra stock.

When you have ripped far enough, shift the work so as to continue sawing between the sawhorses, but keep the latter closely enough together to prevent the work from whipping up and down, which would make accurate cutting impossible.

Bevels are ripped by sloping the saw sideways at the required angle, as is illustrated

MORTISE-AND-TENON JOINTS

[WOODWORKING]



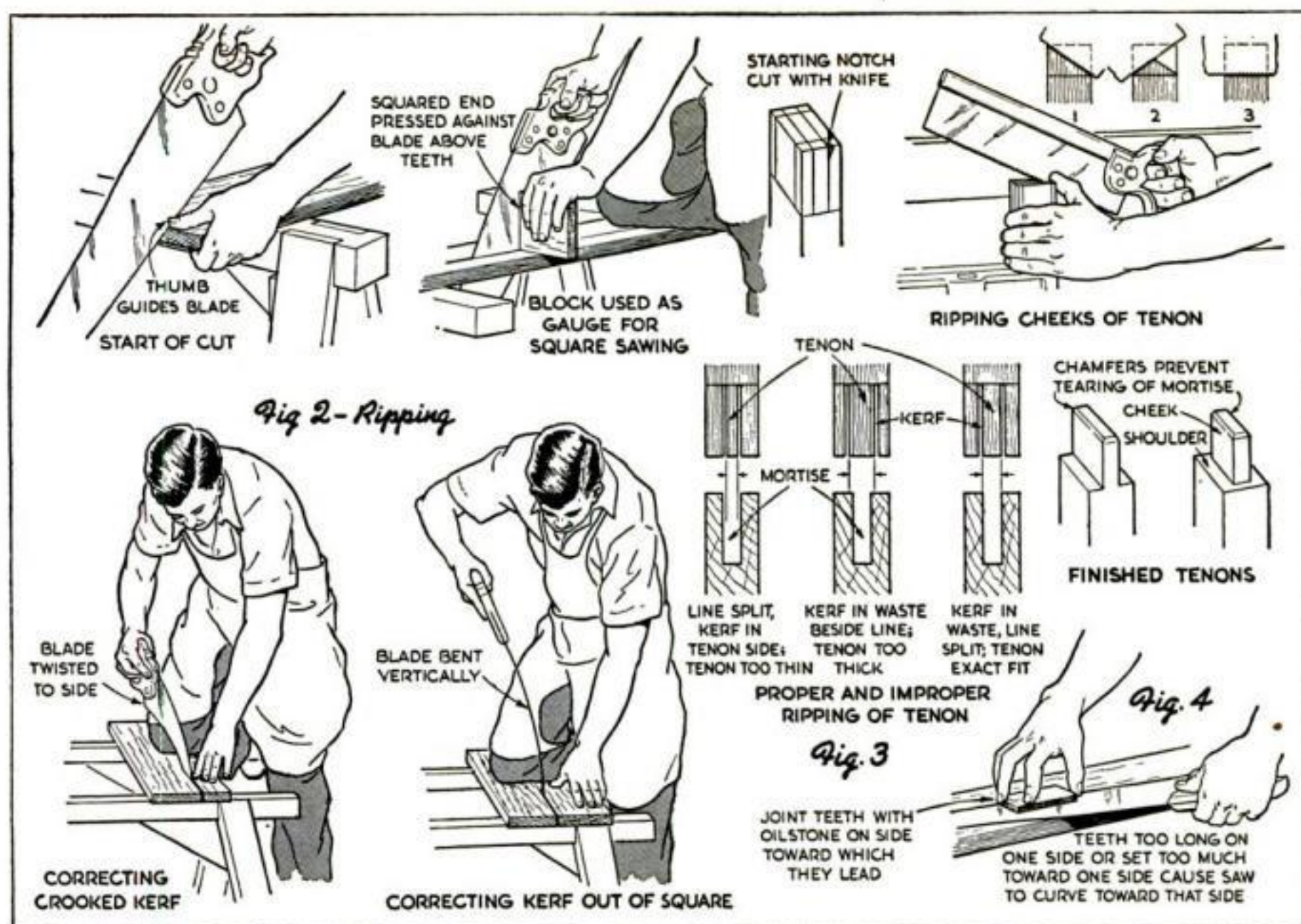
When drawings fail to give dimensions of tenons or a craftsman is designing his own furniture, the following proportions will insure strong joints:

Rail thickness	5/8"	3/4"	7/8"	1 1/8"	1 1/2"	2"
Tenon thickness	5/16"	3/8"	3/8"	1/2"	5/8"	3/4"
Tenon length	3/4"	1 1/4"	1 1/4"	1 1/2"	1 1/2" to 2"	1 3/4" to 3"

Note: Where a tenon is not under much strain, its thickness may be one third that of the rail; many mechanics, in fact, prefer that proportion. The width of a tenon should rarely be more than six times its thickness. Wider joints weaken the mortised part too much, and excessive shrinkage is likely to break the glue bond between the parts. On wide rails, use a double mortise-and-tenon joint consisting of two ordinary joints side by side.

The rail shown is marked out for a shouldered tenon, which will have two faces and two edge shoulders. Plain tenons, which should be used only on less exacting work, are the full width of the rail and therefore have two shoulders, the face cheeks only being cut away.

POPULAR SCIENCE MONTHLY SHOP DATA FILE



in one of the photos on a preceding page.

Can a faulty cut be corrected?

YES. If the cut has wandered from the line, twist the saw handle to the right



Cutting plywood with a crosscut saw. Hold up the sawed edges behind the blade to prevent binding

or left as shown in Fig. 2 until the deviation is corrected. To true an out-of-square cut, bring the blade up to an almost vertical position, and spring it to one side while continuing to saw. The kerf may be tested for squareness by placing a try-square or a block of wood against the blade and the work. A squarely cut wood block can also be used as a ripping gauge in the manner shown in Fig. 2.

What is the secret of sawing a straight line?

A SAW in perfect condition, properly used, will cut a straight kerf almost of itself. The correct stance and a steady hand are, of course, essential. However, if a saw persistently wanders from the line in the same direction, the teeth on that side may be too long or may have too much set. If examination proves this to be the case, the condition may be corrected by jointing the teeth on that side with a fine oilstone (Fig. 4). This should be done cautiously and only after it has been determined that the saw is really at fault.

Why may a blade bind?

INSUFFICIENT set, forcing the saw, working with poorly seasoned wood, or changing the angle of the kerf, may cause binding.

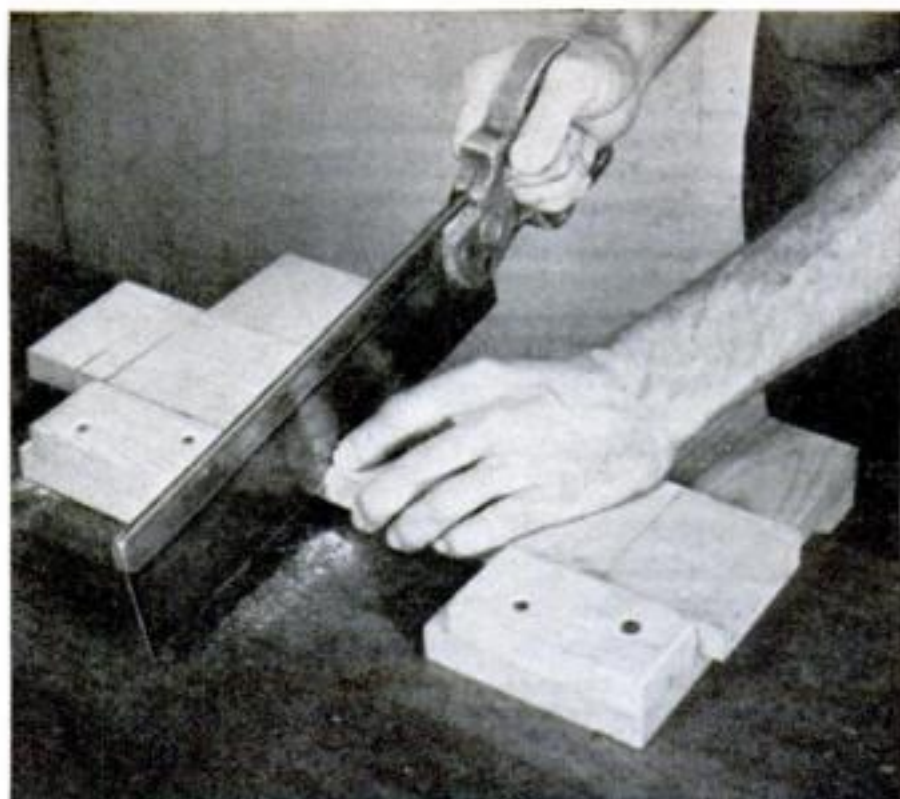
The weight of the saw itself usually provides enough pressure on the teeth for normal cutting, although up to a reasonable limit a little extra pressure will speed the work. The remedies for these conditions are obvious, but sometimes a cut can be finished by pushing a wedge into the kerf to hold it open, or by greasing the saw, or both. However, oil or grease should not be used in sawing parts that are to be glued together, as it may destroy adhesion between the wood and the glue.

How are short boards ripped?

AN ACCOMPANYING photograph shows short work being ripped at a bevel on a sawhorse. The vise also may be used. When possible, place the work at a 45-deg. angle and use the saw with a horizontal stroke. In sawing work held vertically, try to retain the full length of the stroke, using a free arm motion from the level of the hip. It is often wise to gauge the stock on both sides. If the kerf becomes out of square, it can then be corrected by turning the work over and sawing from the other side.

What is the right way to use a crosscut saw?

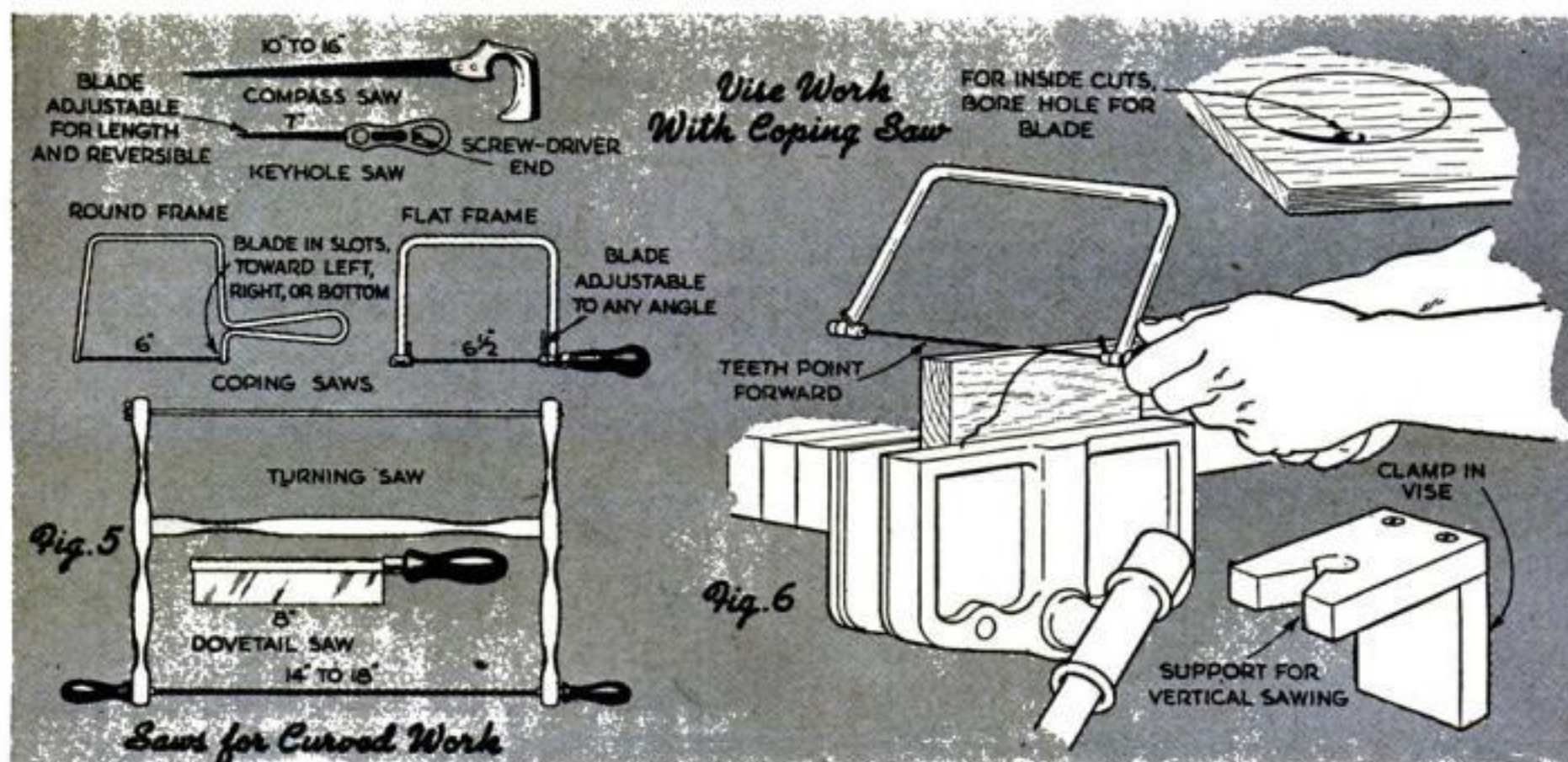
EXCEPT that the cut is across the grain, the work is very similar to ripping. Support the free end of the stock with one hand to prevent sagging, which might cause the blade to bind, and use very little pressure on the last strokes, holding up the part being cut off in order that it may not fall prematurely and splinter the edge. Short work can be held on a sawhorse, on the bench top with bench hooks, as shown in one of the photographs, or in a vise.

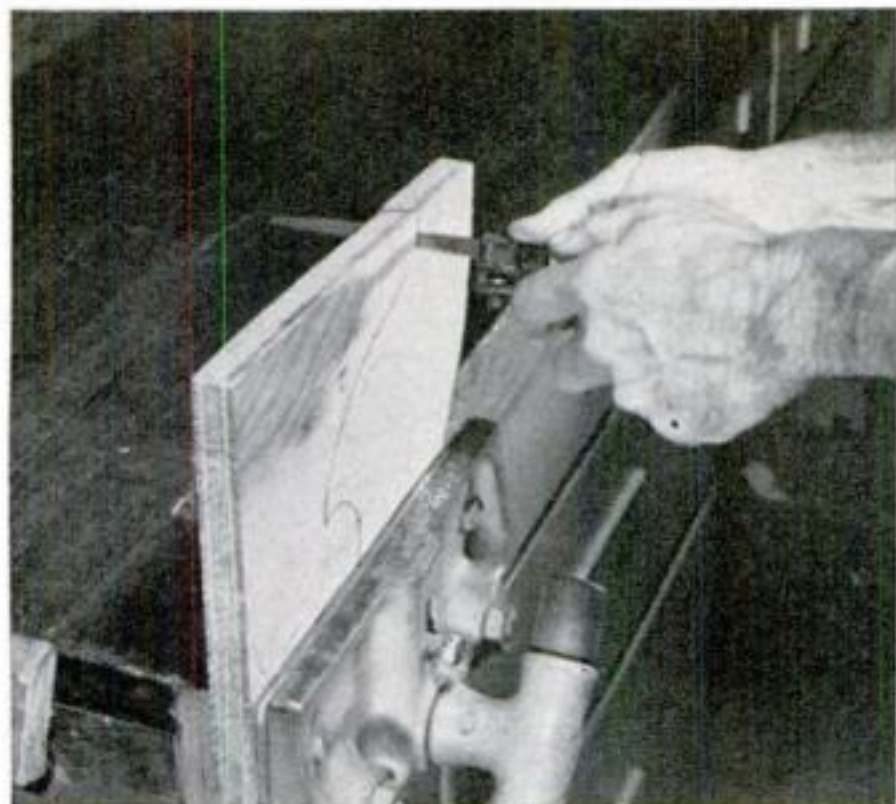


Using a backsaw to cut a dado. The work is held by means of two bench hooks. Tenon shoulders are cut in the same way after the cheeks are ripped.

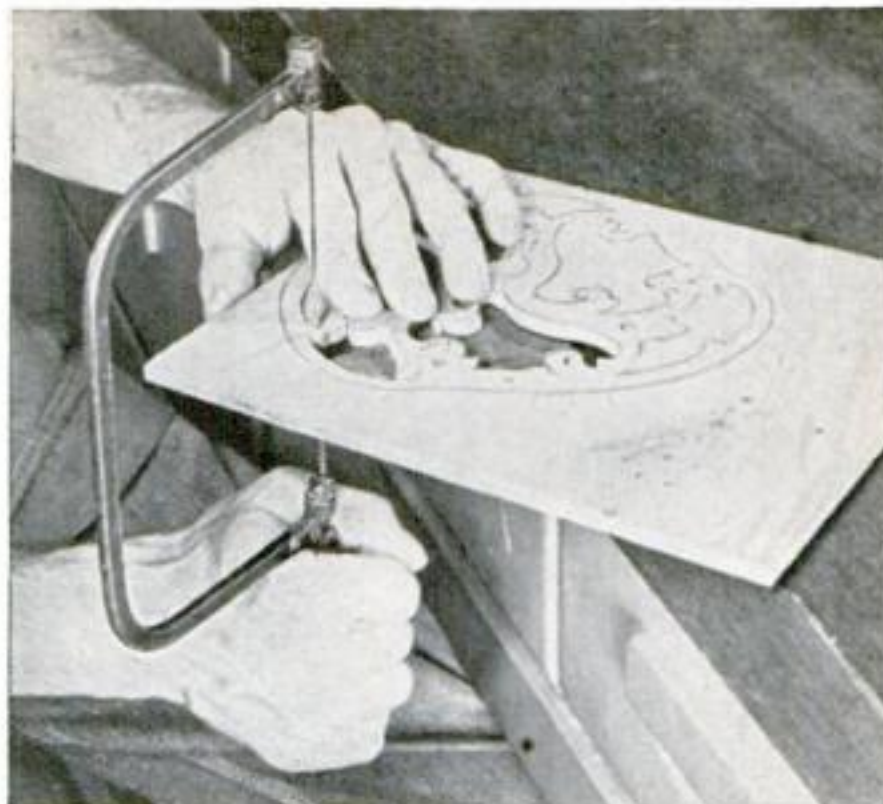
How is a tenon cut?

A BACKSAW is usually used because of its thin blade and rigidity, although a rip saw also works well, especially on wide stock. Clamp the work in a vertical position so that the lines gauged on the end and edge can be seen easily. As the cheek cuts are started by sawing at an angle, some workers prefer to fasten the work in the vise at about 45 deg., keeping the saw blade horizontal. Cut a starting notch on the near edge with a knife, and guide the saw in this so that the cut splits the line, with the kerf in the waste stock. Saw diagonally downward to the shoulder, then reverse the work and saw diagonally to the opposite end of the shoulder, and finally finish ripping the





The keyhole saw is used for curved cuts in heavy stock or in pieces of such a size that it is impossible to employ any kind of saw having a frame



Intricate curves are best cut on a bench pin or a similar notched support. To follow the line, turn the work, not the saw. Teeth must point downward

cheek with horizontal strokes. Figure 3 illustrates these steps, as well as faulty and correctly fitted tenons.

To cut the shoulders, hold the work in the vise or on bench hooks. Start sawing at the far edge, and level off the cut until the waste block is cleanly severed. This method prevents weakening the tenon by accidentally cutting too deeply, as might occur if the shoulders were sawed before the cheeks.

What saws are used in cutting curves?

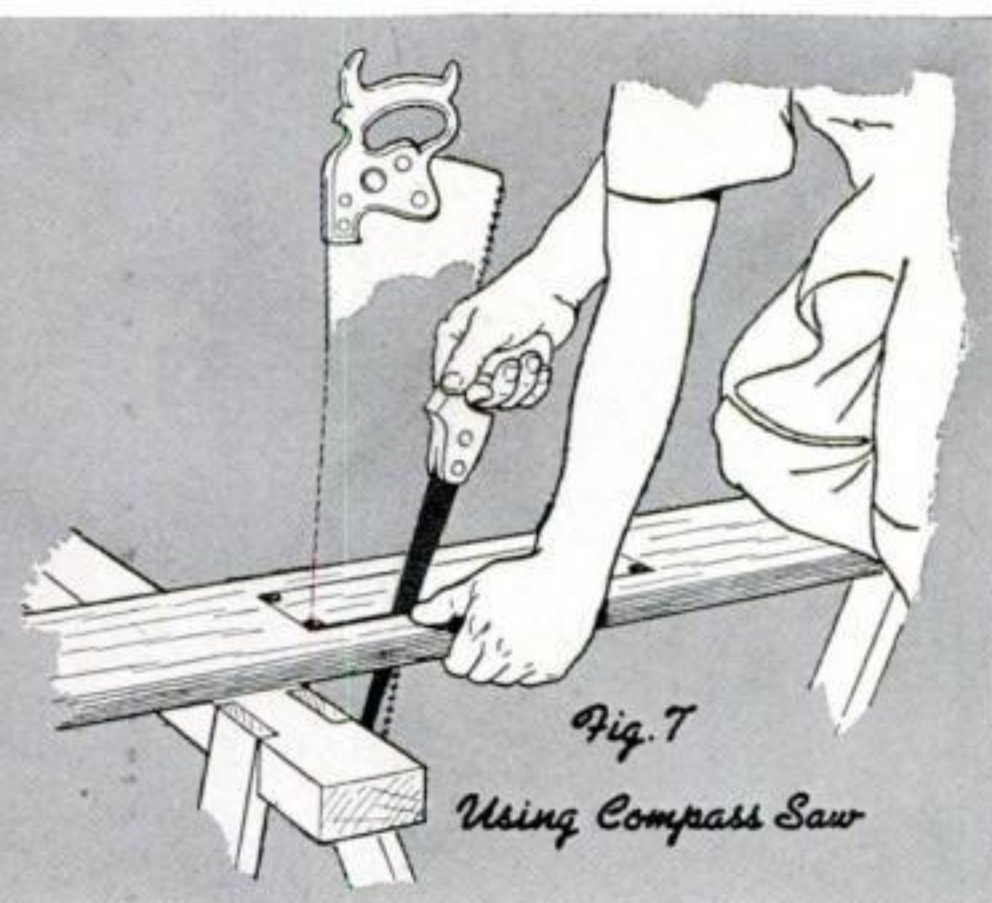
GRADUAL or "slow" curves can be sawed by springing the blade of a rip saw or a crosscut saw around the arc. For smaller curves, use a compass, keyhole, or turning saw. These, as well as coping

saws, are shown in Fig. 5. The coping and bracket saws are for intricate curves and fretwork. One of the photographs illustrates how stock can be held in the bench vise for cutting with the keyhole saw, which is held in one or both hands and used with a horizontal stroke. Beveled cuts are made by slanting the blade. Saw outside the line in order to leave stock for smoothing the cut with a file or spokeshave.

The coping saw is held with one or both hands, or, if the work is clamped in a vise, one hand may grasp the forward end of the frame, and the blade may be reversed so that the teeth point away from you (Fig. 6). Thin stock, however, should be supported on what is known as a bench pin, or else on a block that has a V-shaped notch cut in it. This support may be clamped in the vise or to the bench top, as shown in one of the photographs. The teeth of the saw blade must point downward, and the blade should be kept at right angles to the surface of the work. In following the pattern, it is best to turn the wood and not the saw. Inside cuts are made by threading the blade through a hole. Such holes should also be drilled wherever necessary to avoid having to make excessively sharp turns.

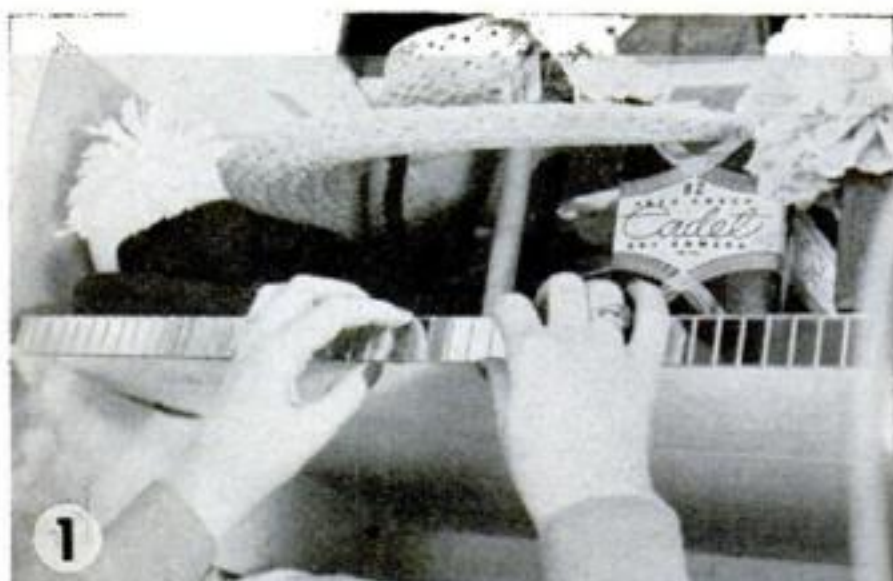
Figure 7 shows how a compass saw is used to cut a drawer opening in the apron of a table. The narrow blade is inserted through holes bored for the purpose. When a sufficiently long kerf has been sawed out, the rip saw can be used instead for faster cutting. The shorter cuts across the width of the opening must, of course, be made with the compass saw alone.

The dovetail saw is for light cutting and delicate work. It is held in one hand. Model makers find it particularly useful.



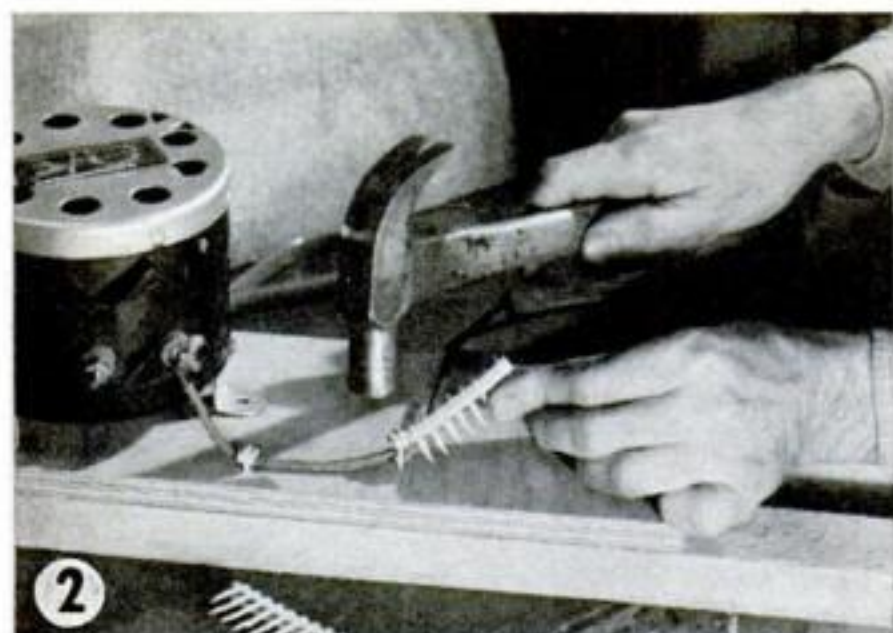
New Appliances

1



TINY GLASS MIRRORS in adhesive-backed strips are for use as edging on closet or other shelves, or as general wood trim. The strips are flexible, may be applied to curved or straight edges, and can be bent around sharp corners. They are made in three designs each of crystal, blue, and gold

2



INSULATED STAPLES used in fastening electric wire are handy when obtained in strips. The end staple is bent back for driving, the rest forming a convenient handle. When in place, a twist will detach it. Colors are available to match wiring

3

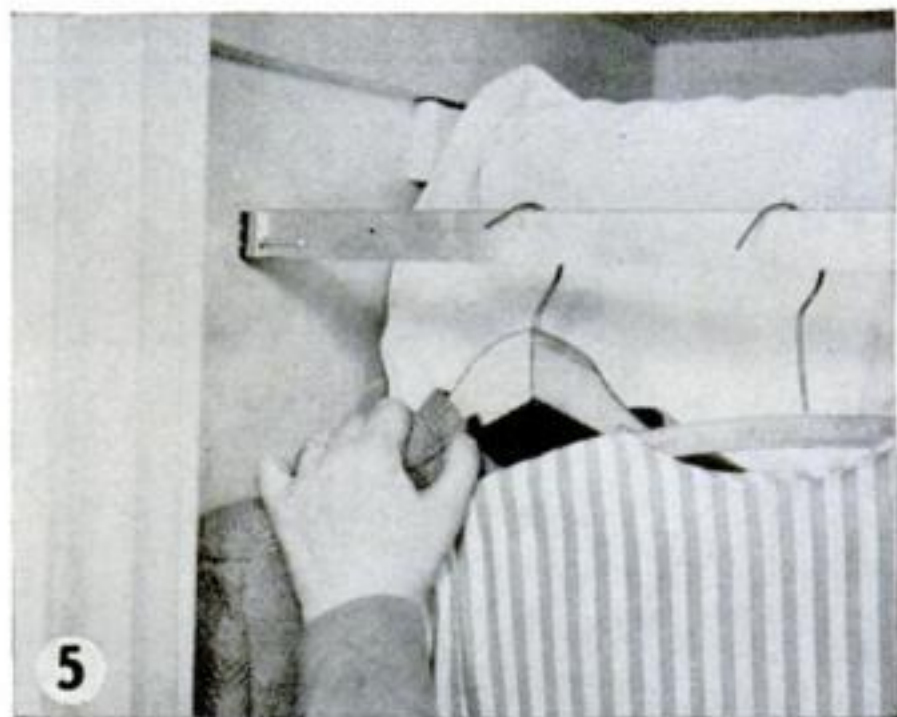
CANS THAT HEAT THEMSELVES add to the joys of picnics. The cans are double, with a chemical between the walls that heats on contact with air. Turn a can over, punch four holes, and let stand about fifteen minutes. The result will be piping hot, ready-to-serve spaghetti, beans, or coffee

4

ACCURATE KITCHEN SCALES, modern in design and enameled in white and a bright color to match canister sets, will weigh up to 25 lb., marked in ounces on a revolving dial. Steel springs are arranged to prevent stretching beyond their limit

5

ADJUSTABLE TO FIT THE CLOSET, these rods are supported by pressure on rubber end pads, and require no nails, screws, or brackets to put up. Of rustproof steel, they may be used for shoes, clothing, shelves, window or shower curtains, or towels. They are strong enough to hold 100 lb.



for the Household

6

EQUIPPED WITH A HEADLIGHT, this electric iron guides the way around buttons and difficult spots. It has a steam attachment which clamps to the side of the board and connects with the iron through a hose; also a spring-clip arrangement to keep the cord raised and away from heat, and a control for selecting temperature for 15 fabrics. A glow light winks when the right heat is reached

7

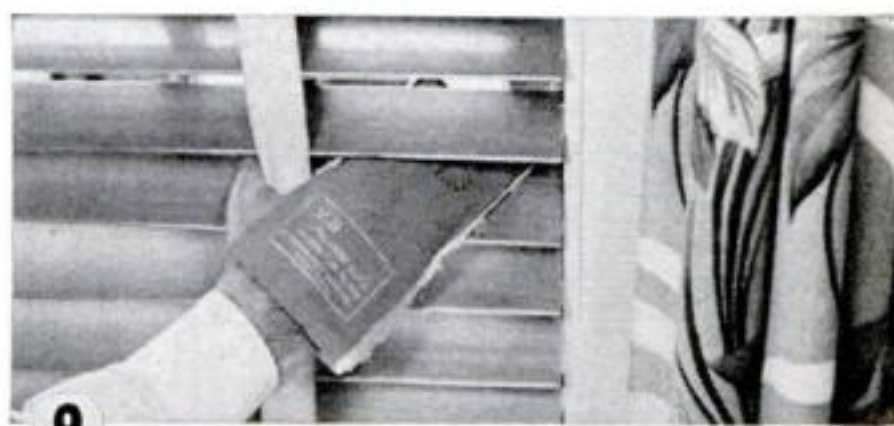
WINDOW PRIVACY IS INSURED, glare shut out, and the dust nuisance minimized by this new shield. Steel bending bars, passed through top and bottom hems of curtain material, slide in or out of four sockets attached permanently to the window frame

8

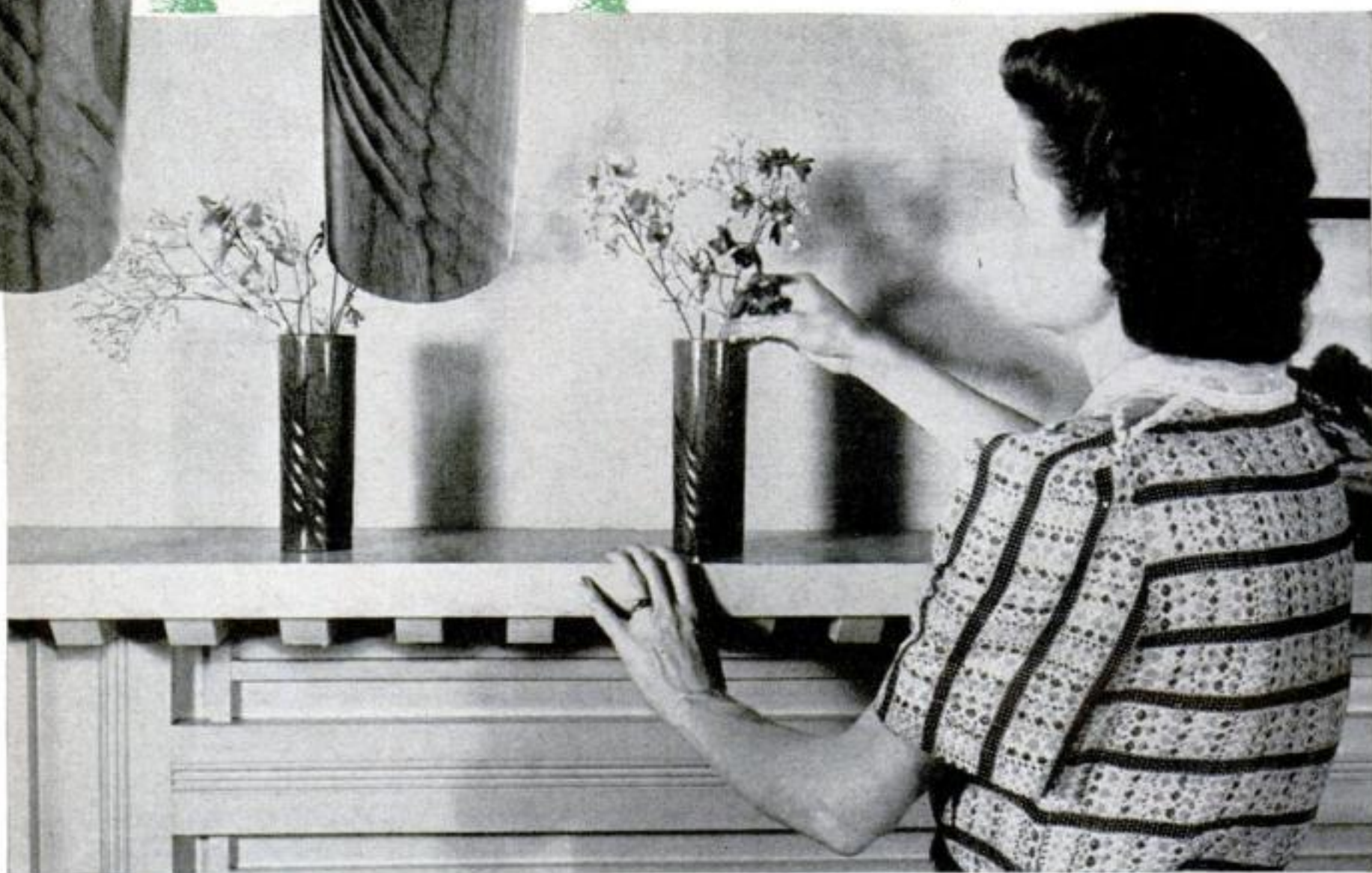
SELF-SHARPENING, this paring knife is a new and handy gadget for the kitchen. When the blade dulls, a simple pull and push on the shaft renews the cutting edge. This may be done in the midst of peeling vegetables without bothering to rinse or wipe off the knife. A spring-steel device in the plastic handle does the honing, and grips for thumb and finger reduce the possibility of slips

9

FOR CLEANING VENETIAN BLINDS, a complete kit is now available. It consists of a cleaning fluid, a lamb's-wool polishing glove, and a bottle of fabric cleaner for use on the tapes and cords. The special cleaning fluid leaves a hard, smooth, protective coating on the slats, and is applied simply with a cloth or natural sponge. Once dry, it is rubbed briskly with the lamb's-wool glove to bring out the luster. The design of the glove is such that the top of a slat and the bottom of the one just above it can be polished in one operation



Craftwork articles such as these fluted vases make beautiful and distinctive Christmas gifts, often of a kind that could not be bought on the open market. The vases shown have water-tight inner containers



Spirally Fluted Wooden Vases

HERE'S A NEW TRICK FOR WOOD TURNERS . . .

IF YOU are looking for a lathe project a little out of the ordinary, try making these wooden vases with their decorative flutings. For each vase turn a piece of walnut or other hardwood $7\frac{1}{4}$ " long with a diameter of $2\frac{5}{8}$ " at one end and $2\frac{3}{8}$ " at the other. Sand the turnings smooth.

From 24-gauge sheet metal, cut and bend a guide to be used in the spiral fluting. This is screwed to the ends of each vase turning as illustrated in one of the photographs. A hardwood stick 12" long and 1" in diameter is turned smooth and around it a strip of sandpaper is glued to form a sanding drum. Run the lathe at its highest speed, and hold the block against the drum, following the metal guide as you rotate the piece. When one flute is finished, set the guide over for the next flute. It is a good idea to make tests on waste stock to determine the

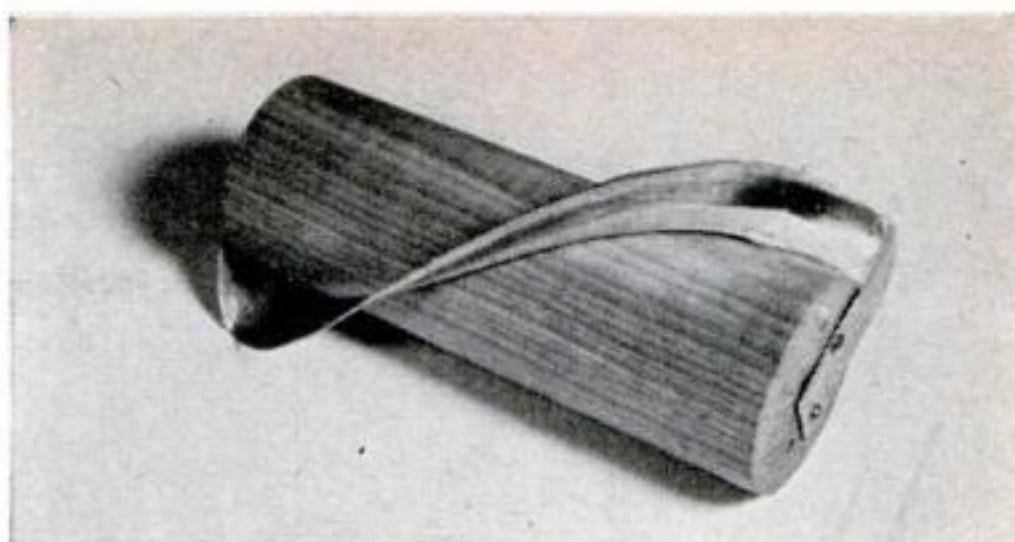
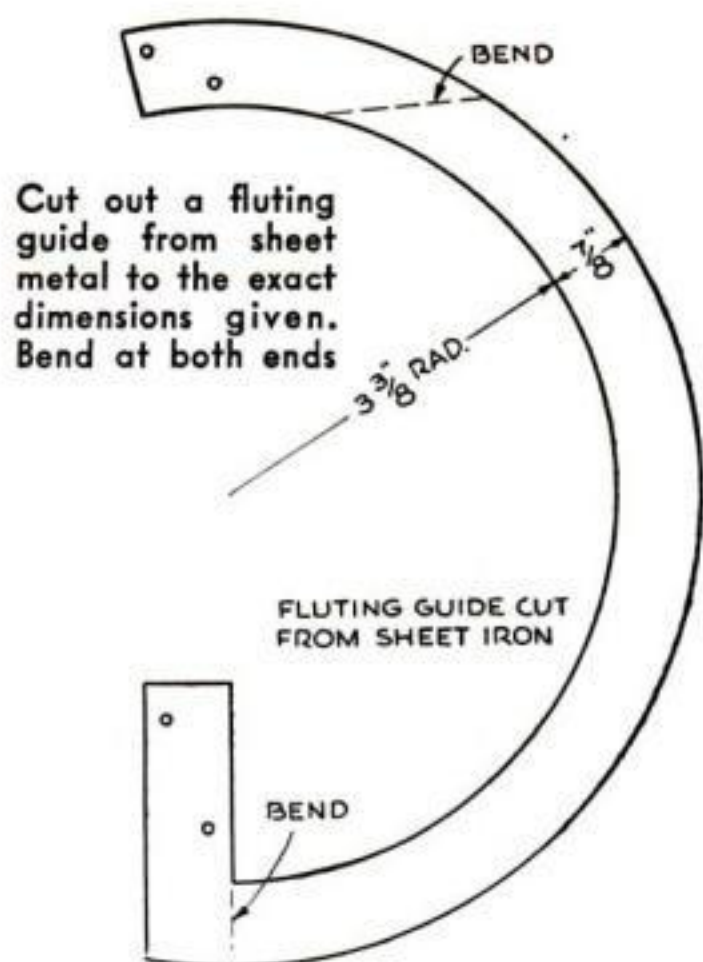
proper guide settings. Continue until the desired number of flutes have been made.

Now mount the turning by its large end on a faceplate and turn it out to an inside diameter of $1\frac{5}{8}$ " for half its length. From $\frac{3}{4}$ " stock turn a bottom plug and glue it into a turned recess as shown.

When the glue is dry, mount the turning on the faceplate by the bottom and turn out the upper part also to $1\frac{5}{8}$ " diameter.

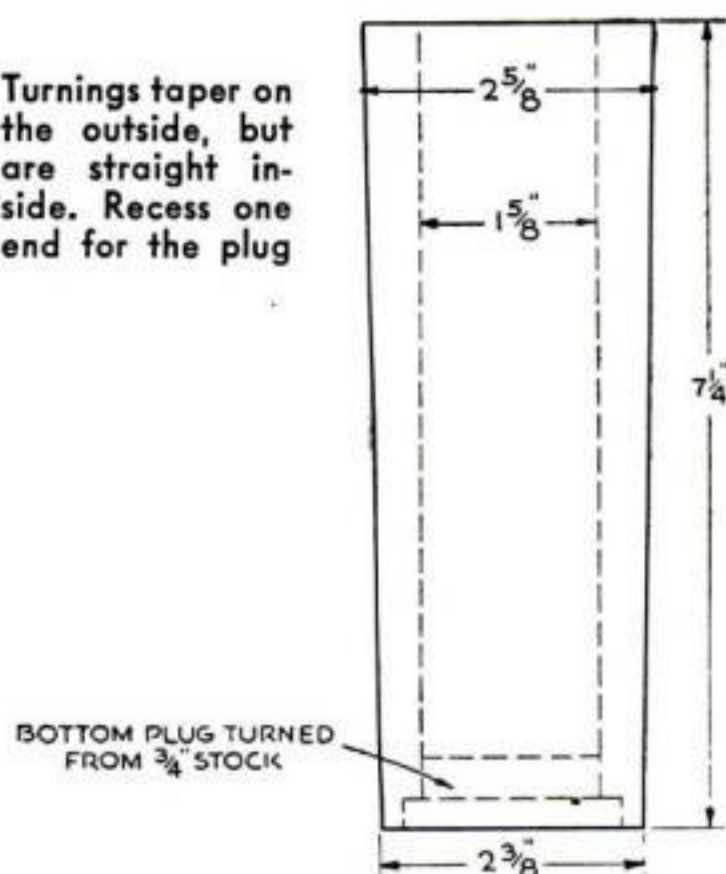
Finish each vase with three coats of shellac, rubbing down the surface between coats with fine steel wool. Glue felt or blotting paper on the bottom of each vase.

Water-tight containers for the vases illustrated were made from old brass tubing obtained from a plumbing shop. These measure $1\frac{1}{2}$ " in diameter by $6\frac{1}{4}$ " in length, and are closed with metal disks soldered to the bottoms.—BENJAMIN NIELSEN.



The fluting guide, carefully and smoothly bent to shape, is attached to each of the solid turnings as above. Fluting should first be attempted on scrap

Turnings taper on the outside, but are straight inside. Recess one end for the plug



Water-tight inner containers can be made by soldering metal disks into the ends of 6 1/4" lengths of brass pipe. Pieces from a plumber's scrap pile will serve the purpose



Holding the guide gently against the sanding drum, turn the piece evenly to form a spiral groove of uniform depth. Reset guide for successive flutes



When fluting is completed, fasten the work by the large end to a faceplate and turn out the inside halfway, as well as the recess for the bottom plug



Glue the plug in place, allow to set firmly, then remount the work to turn out the remaining part. A simple rubbed shellac finish completes the pieces



Napkin Holder Displays Curious Lattice Effect

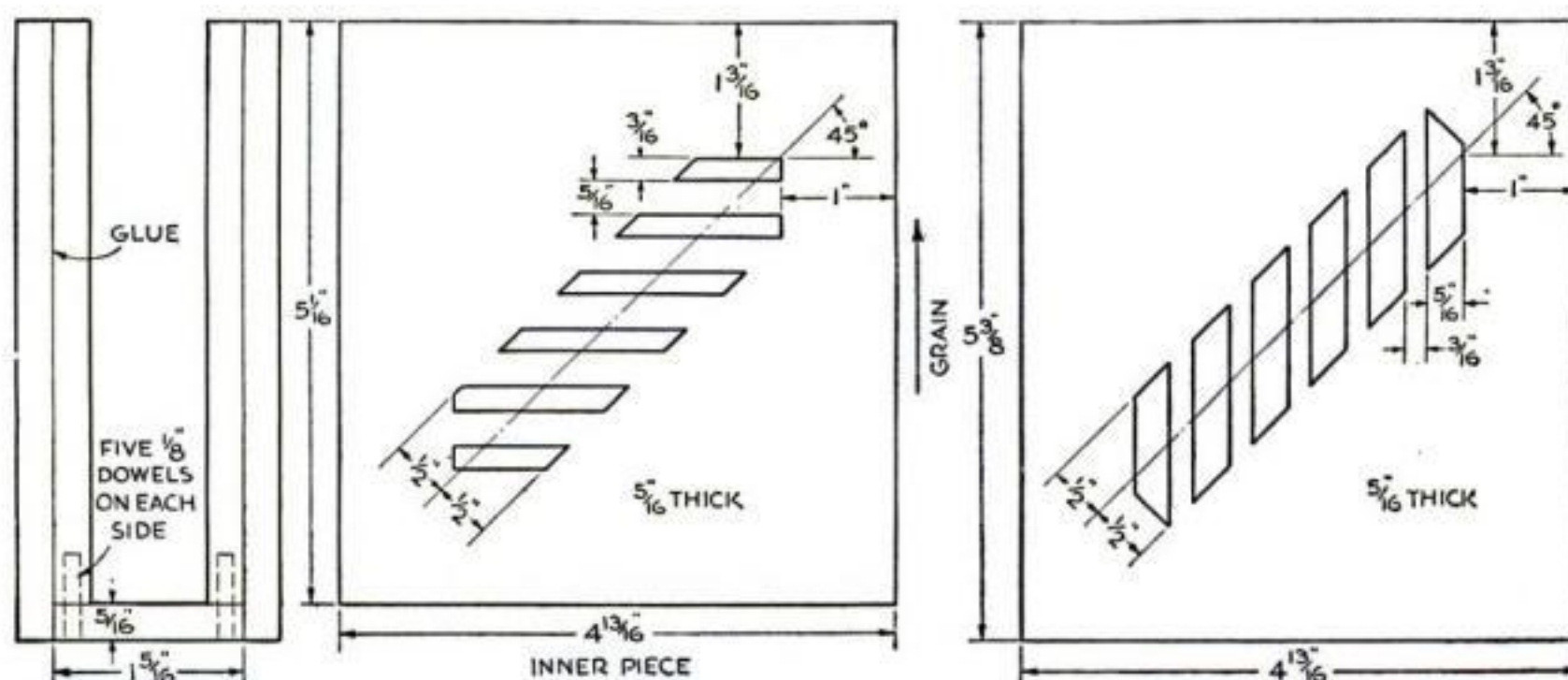
SMALL pieces of nicely grained wood can be used to advantage in making this distinctly different napkin holder. If a band saw is available, the two panel patterns may be laid out on $\frac{5}{8}$ " stock, jig-sawed, and split on the band saw to make four pieces $\frac{1}{4}$ " thick. Alternatively, two pieces of $\frac{1}{4}$ " stock can be glued together, with paper between the joint, and separated after the inside cuts have been made. Cut the inner pieces slightly oversize to allow for trimming them accurately to shape after they have been glued to the outer ones.



Glue up the parts as shown, and attach them to a base by means of $\frac{1}{8}$ " dowels pinned into the inner panels. Finish with two or three coats of thin shellac, rubbed down with very fine abrasive paper, and wax. Approximate time, 3 hours.



Outer panels are chosen for best grain

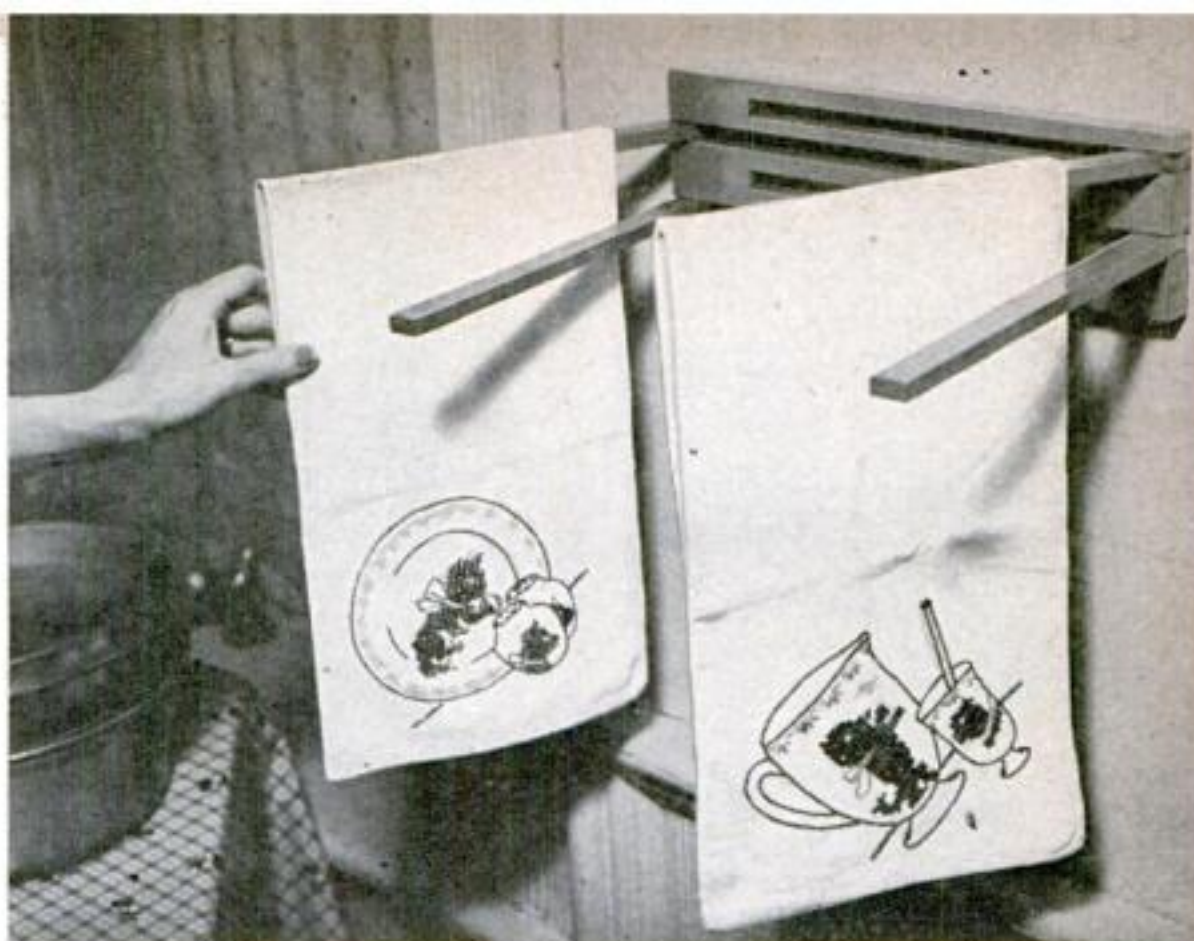


Folding Towel Rack Sawed from One Piece of Wood

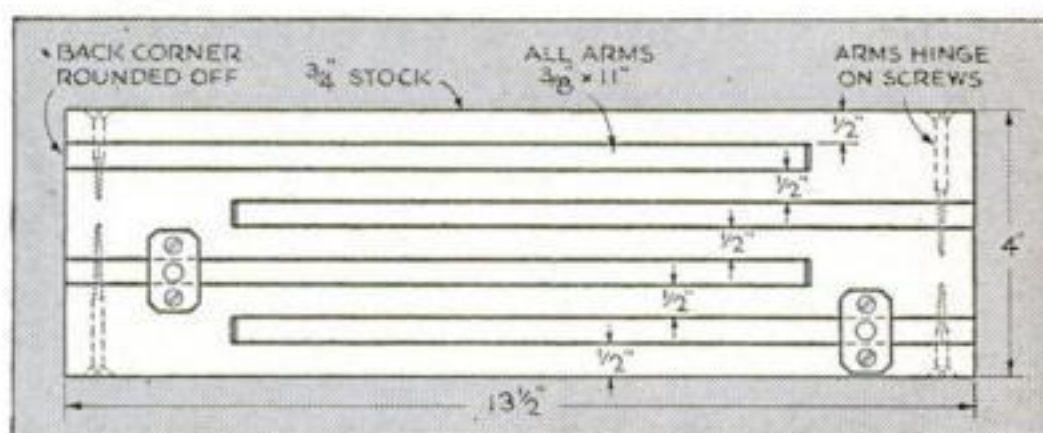
ONE piece of wood is all you need to make this novel folding towel rack, which takes scarcely any room when not in use. Rip the stock as indicated in the diagram at the right, using a circular saw, if possible, and keeping the same side down so that the short superfluous kerfs due to the curvature of the blade will all be at the back of the finished piece. The short transverse cuts can be made on a band saw, a scroll saw, or with a hand coping saw. Round the back corners of all four arms so that they will clear the wall and swing out freely. Replace them in the back, and drill holes for wood screws or a $\frac{1}{8}$ " metal pin through both arms and back at the same time in order to insure perfect alignment.

Two flat metal plates are screwed on from the back as shown in the drawing, and the covering arms swung aside in order to insert screws for mounting the rack on the wall.

The towel rack can be finished in colored enamel to match any kitchen or bathroom color scheme. The approximate working time is $1\frac{1}{2}$ hours.



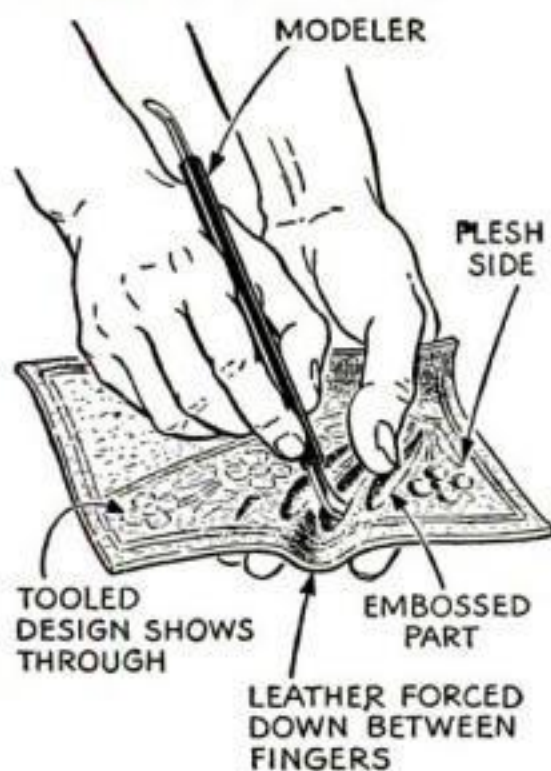
Smoothly working arms swing out from the rack to hold kitchen towels. When not in use, they fit back flat in the slots.



Pattern for sawing arms and back from one piece of stock, and illustrating the method of attaching wall screw plates

EMBOSSING

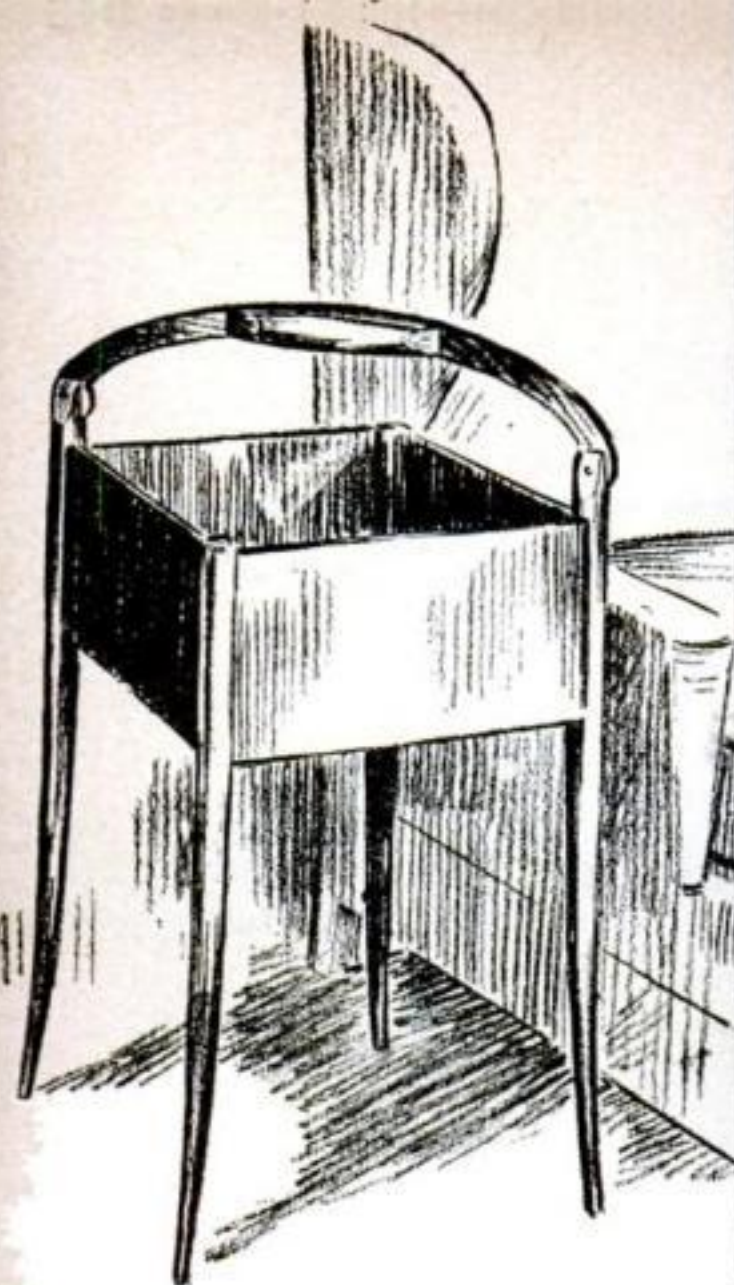
[LEATHER CRAFT-6]



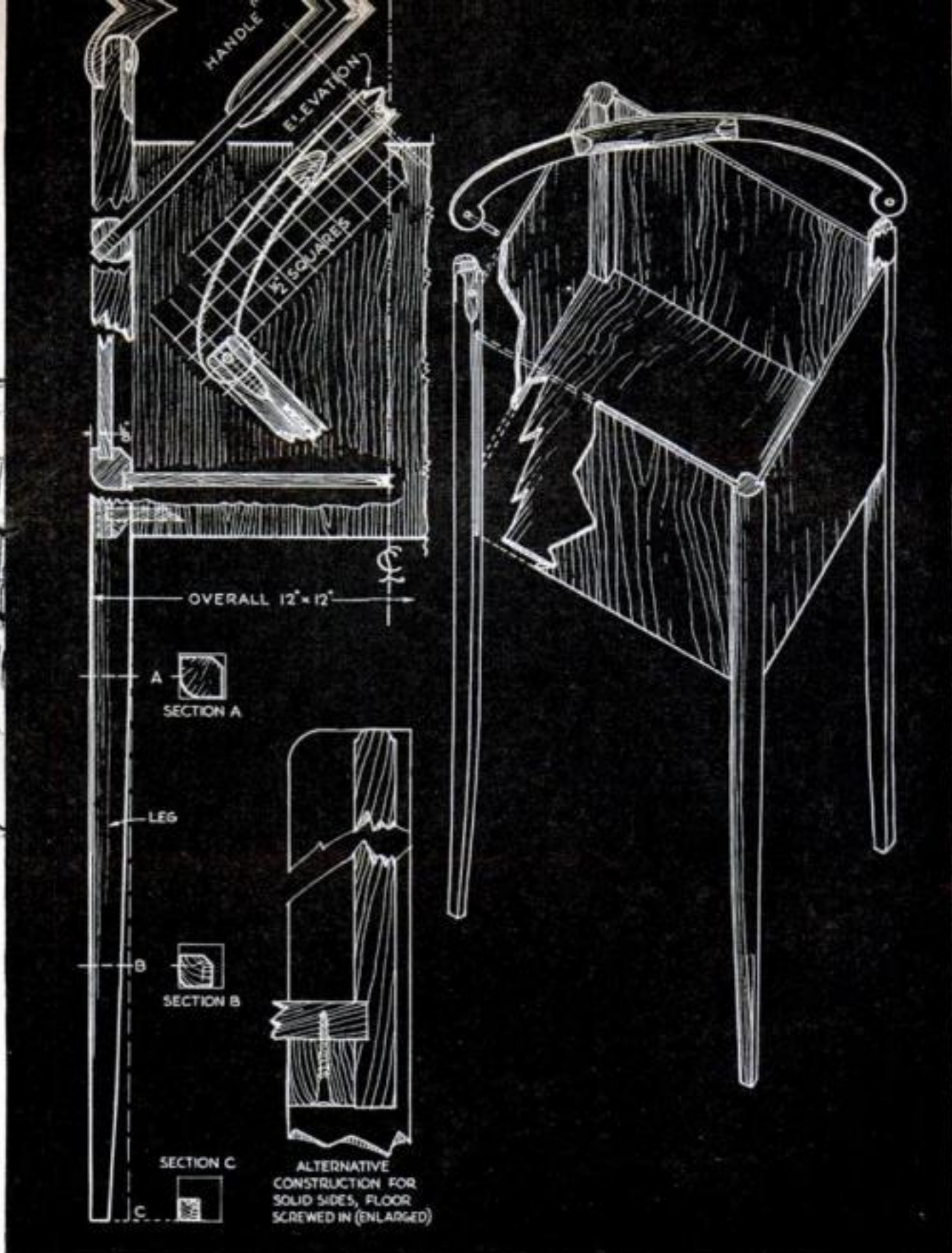
Embossing produces designs that are raised above the original leather surface.

Make the design and shade all parts to be embossed. Transfer design to leather and tool it (Leather Craft-4). This should produce a clear outline of the design on the flesh side. Hold leather with flesh side up and force leather to be embossed down between fingers, using broad end of modeler or ball point. Then place flesh side of leather on marble and put down leather around embossed parts. Repeat these operations until leather is raised to desired height. Do not over-emboss. Large embossed parts should be backed with a mixture of flour, kapok, and water. Keep this filling level with background. Turn leather over and lightly outline design and all lines in embossed parts. After leather dries, cement lining over kapok backing.

POPULAR SCIENCE MONTHLY SHOP DATA FILE



Careful beveling and tapering of the inner faces of the legs on the knitting box above, and rounded outer corners, result in a delicate, graceful flare



Two Knitting Boxes...

TIMELY GIFTS FOR RED CROSS WORKERS

BY JOSEPH ARONSON

Author of *The Encyclopedia of Furniture*

NOW that knitting has become an almost universal pastime among women, why not put one or both of these attractive knitting boxes on your craftwork gift list? Either one will hold a good-sized piece of work and plenty of the "makings," yet remain light enough to be carried easily from room to room.

As all dimensions have been held to a minimum, the joints must be carefully made. The legs of the first box, which are cut from $\frac{7}{8}$ " square stock, are rounded on the outer corner to within 3" of the bottom ends. Taper the inner faces of each leg, with a slight curve, starting from a point

12" up, to bring the cross section at the foot down to one fourth the original square. Then bevel the inside corner from a height of 13" to within 3" of the foot. Careful work with plane and sandpaper will produce the delicately flared leg so characteristic of good English and French designs.

A molded upper edge on the sides, which will leave only the core to show long grain, will stain nicely. The molding should, however, stop short of the ends, leaving square edges to fill the $\frac{1}{4}$ " deep dadoes in the legs. Glue in the sides with the outer grain vertical. The floor also is dadoed into the sides with $\frac{1}{8}$ " sinkage, and braced with small glue blocks. If solid stock is used for the sides, do not glue in the floor, but screw it to cleats in turn glued to the sides, as shown in the large detail, to allow for shrinkage.

Shape and slot the diagonally opposite longer legs for the handle rail, which is pinned with tightly fitted $\frac{1}{4}$ " dowels. Shape the handle grips and glue them on.

The second box shown has a hopperlike body that calls for precise cutting of its spline-mitered corners and the angular rabbet into which the floor is set. The upper edge of each side curves down at the ends. Turn the handle shaft with a dowel tenon at top and bottom. Leave the lower shaft square, and fasten it to the floor plate with wood screws.

Taper the band-sawed legs in thickness from top to bottom. Pin them to the shaft with dowels passing through the latter. Glue the handle shaft in place through the floor and floor plate, and for additional strength insert a 1" wood screw through the dowel joint as shown. Other wood screws inserted at an angle hold floor and plate together.

The handle must be shaped by hand. Glue it to the upper tenon. Soften all sharp edges by careful sanding. If nicely grained

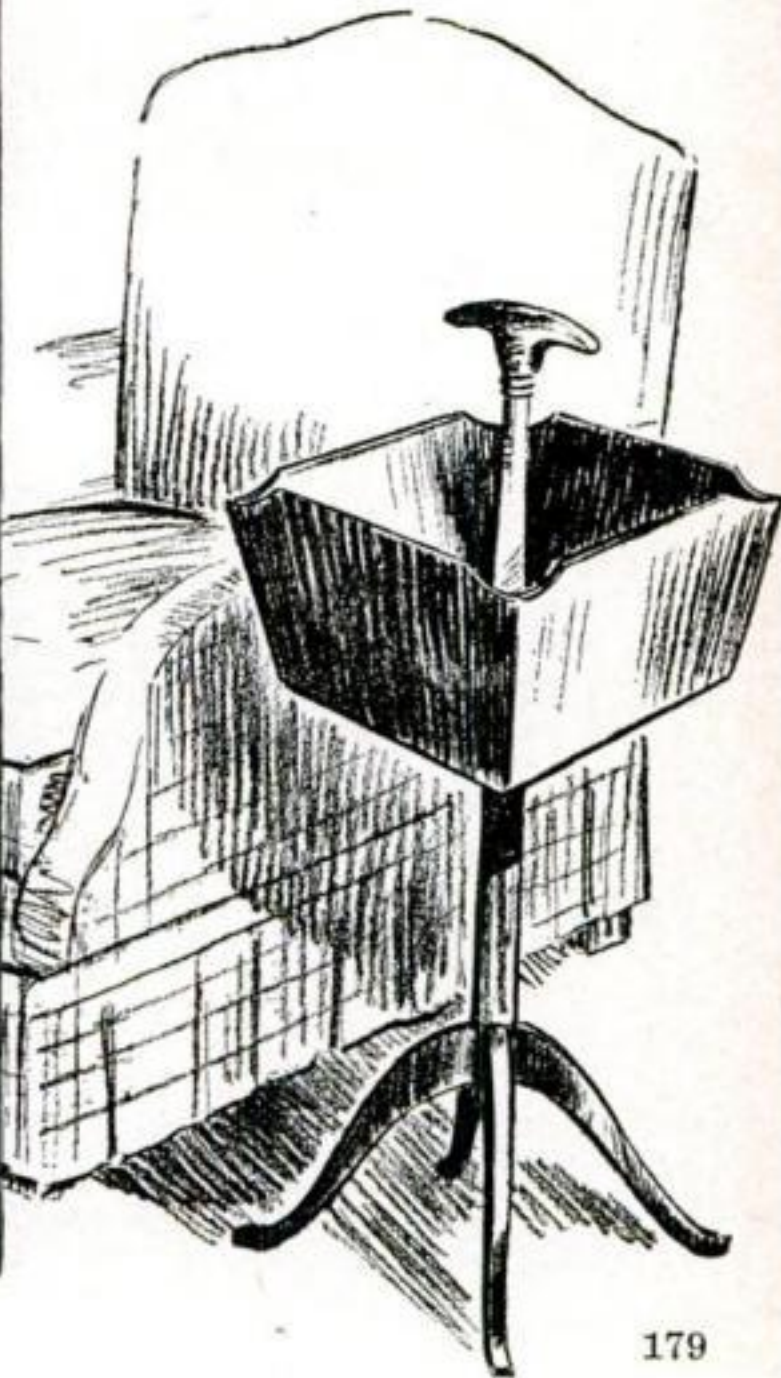
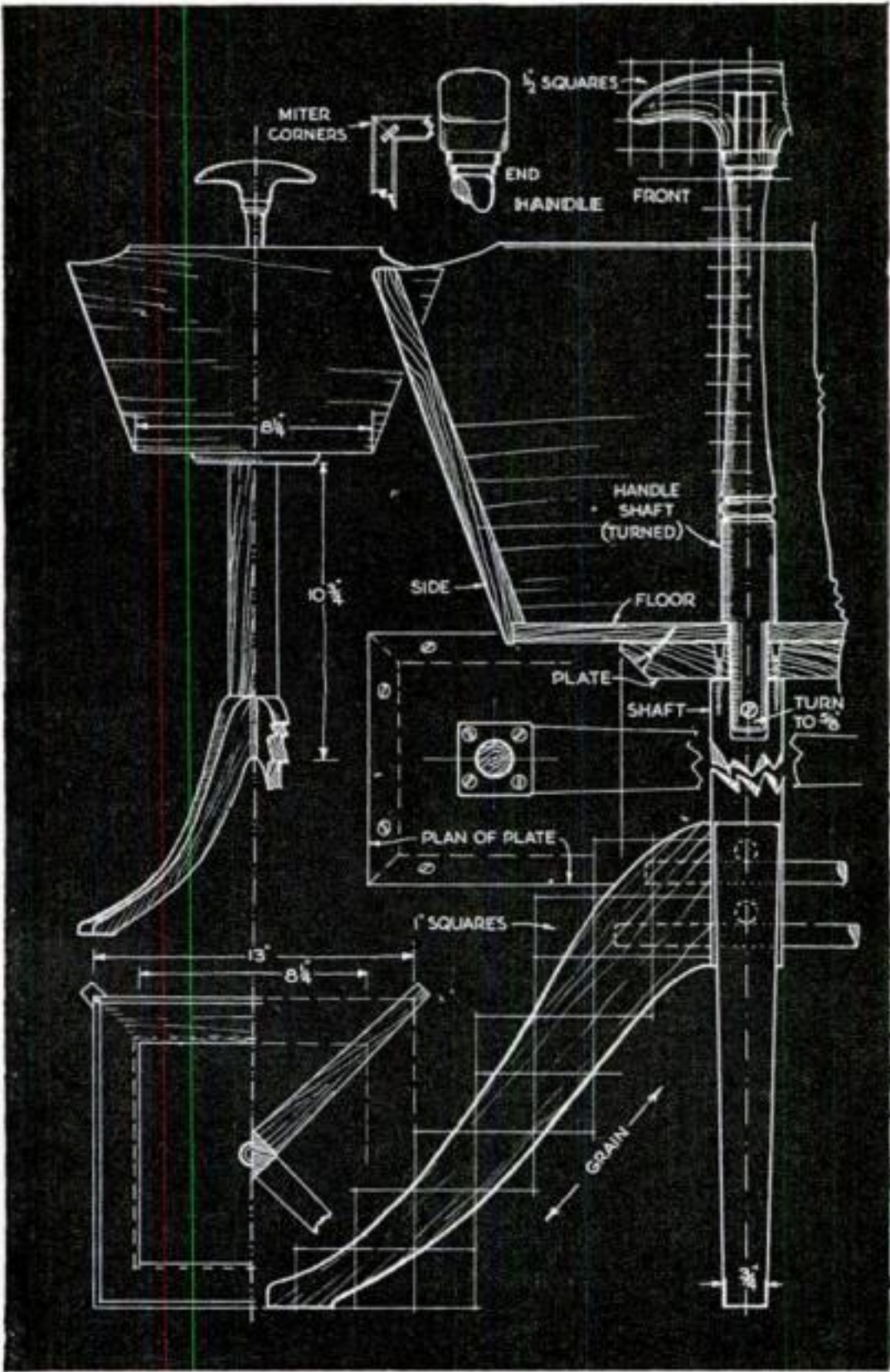
LIST OF MATERIALS				
BOX No. 1				
No. Pc.	Description	T.	W.	L.
2	Legs	$\frac{7}{8}$	$\frac{7}{8}$	22
2	Legs	$\frac{7}{8}$	$\frac{7}{8}$	24
4	Sides (plywood)	$\frac{1}{4}$	8	$10\frac{3}{4}$
1	Floor (plywood)	$\frac{1}{4}$	$11\frac{1}{2}$	$11\frac{1}{2}$
1	Handle rail (plywood)	$\frac{1}{4}$	$2\frac{1}{2}$	$17\frac{1}{4}$
2	Handle grips	$\frac{3}{8}$	$\frac{7}{8}$	$4\frac{1}{4}$

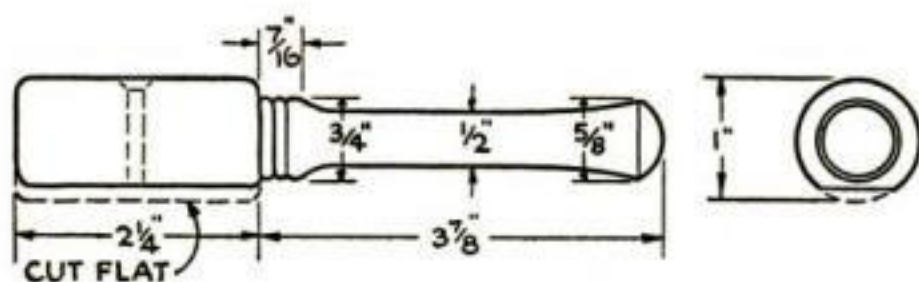
BOX No. 2				
1	Shaft (square)	$1\frac{1}{4}$	$1\frac{1}{4}$	$10\frac{3}{4}$
1	Handle shaft (turned)	$\frac{7}{8}$		11
4	Feet	$1-1/16$	$2\frac{1}{4}$	11
4	Sides	$\frac{3}{8}$	$7\frac{1}{4}$	13
1	Floor (plywood)	$\frac{1}{4}$	8	8
1	Plate (plywood)	$\frac{3}{4}$	$4\frac{1}{4}$	$4\frac{1}{4}$
1	Handle	$1\frac{1}{8}$	$1\frac{3}{8}$	4

Note: All dimensions are given in inches and are finished sizes.

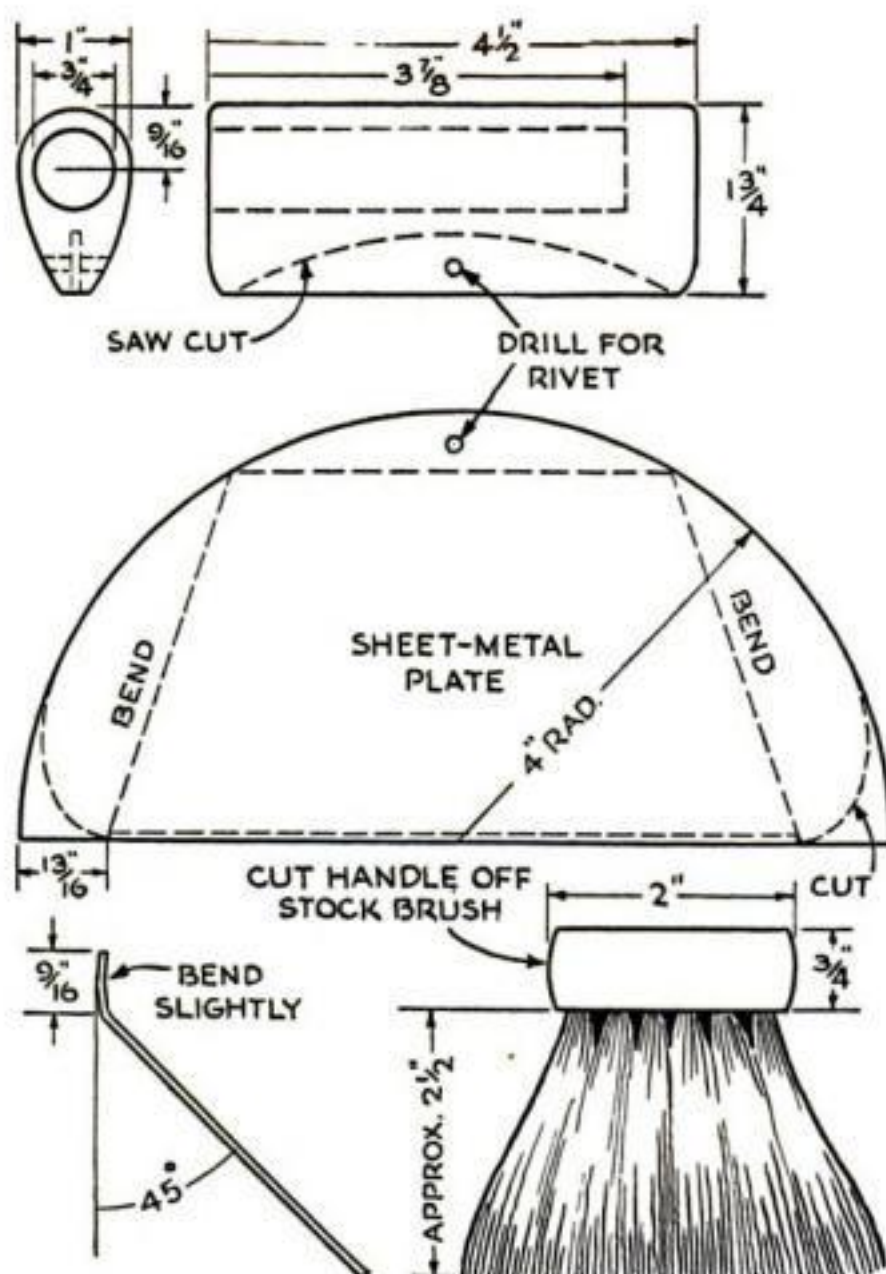
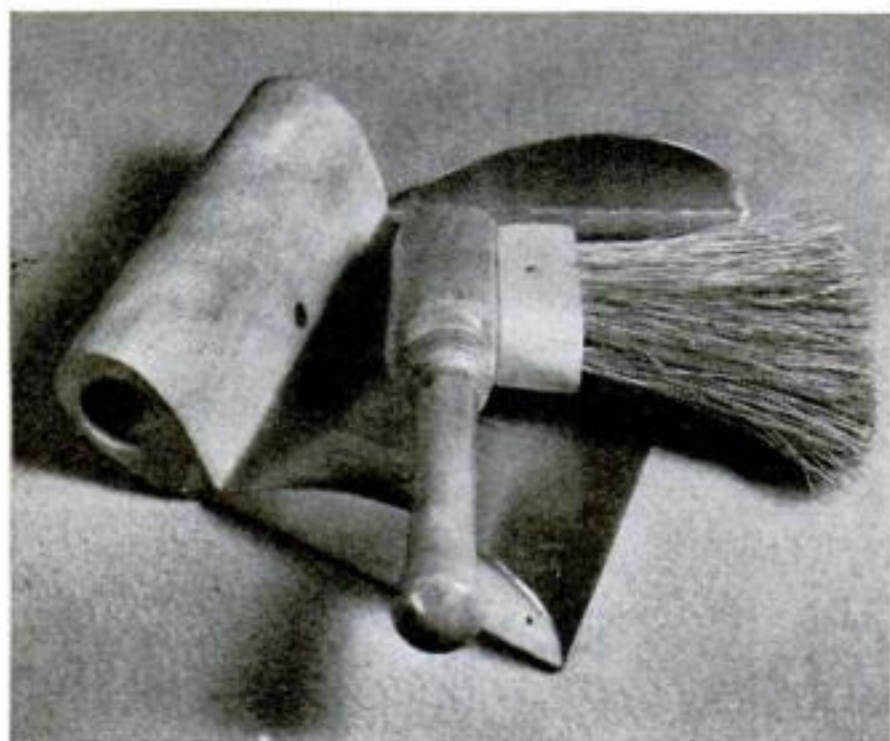
wood is used; it should be finished with stain and shellac or varnish, rubbed to a satin luster, to take advantage of the natural beauty of the grain. Plywood may, if preferred, be finished in colored lacquer or enamel.

Precise cutting of the spline-mitered corners and angular rabbet into which the floor fits is necessary to construct the hopperlike body of the box below





Metal and a richly grained wood make this table tidier a welcome gift for Christmas. It can be turned out at home in the course of an evening



Distinctive Craftwork



PREPARED ESPECIALLY FOR POPULAR SCIENCE
ERNEST R. DEWALT, INDUSTRIAL DESIGNER AND

THIS Christmas, why not give something nobody else can—your own craftwork? Now is the time to begin making gift articles. The two shown on these pages are practical, useful, and distinctive in design.

TABLE TIDIER. Here is something to please the lady of the house. The article shown was made of primavera, a beautifully grained, straw-colored South American wood, and sheet copper, but other combinations may be used.

To make the handle, drill a $\frac{3}{4}$ " hole lengthwise $3\frac{7}{8}$ " deep in a block of wood 1" by $1\frac{3}{4}$ " by $4\frac{1}{2}$ ". Hold the block against a stop on the circular-saw table, and carefully lower it against the blade to form the semi-circular groove for the shovel blade. Then plane or sand the wood to shape.

Cut a semicircle of $\frac{1}{32}$ " thick metal, trimming the two corners as shown. Bend up the edge on three sides, and bend the

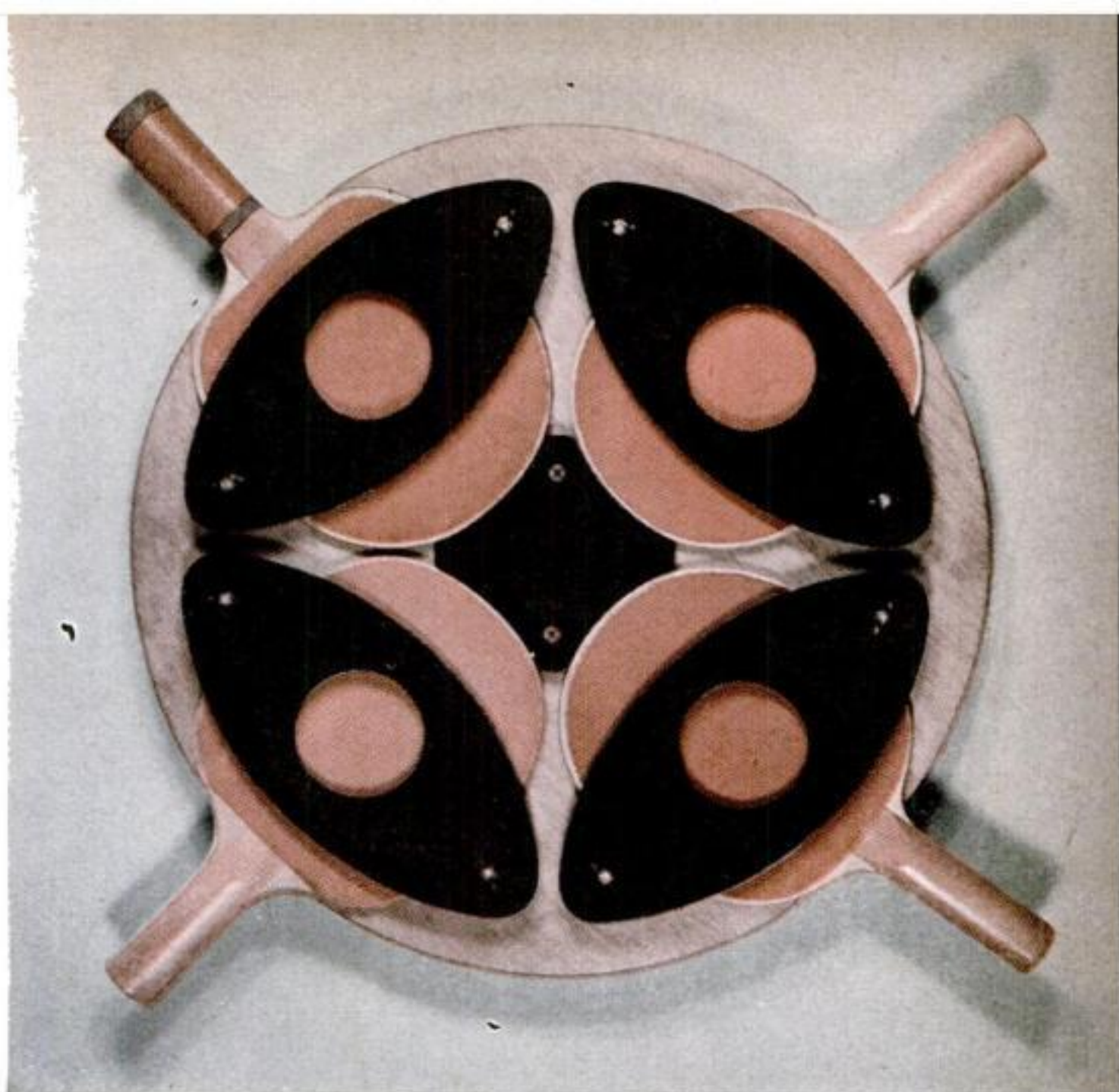
middle flange slightly so that it will wedge firmly in the slot. Clean the metal thoroughly with steel wool and fine abrasive paper; then apply a coat of clear lacquer to prevent tarnishing. Fasten the blade in the handle with one or two metal rivets.

A soft fiber brush is purchased, the handle cut off, and another turned and fitted as shown. Make the shoulder a press fit in the shovel handle, and fasten to the brush with a single countersunk screw.

Finish the wooden parts with two coats of clear lacquer or varnish. Approximate time, $2\frac{1}{2}$ hours.

TABLE-TENNIS PADDLE PRESS. Four paddles, each in its individual press, are accommodated in this unique game-room accessory. It is intended to be mounted on the wall and revolves freely for convenience in racking or removing the bats. Initials, a club insignia, or a decalcomania can be applied to the piece in the center.

Distinctive is this press for holding an entire set of four table-tennis bats within convenient reach on the wall of the game room. It is designed to revolve to make it easier to rack or take out the paddles. Its construction throughout is of plywood, and it may be finished in striking colors or in a simple modern manner. A detailed drawing, below, gives all dimensions for both the revolving table and the supporting disk

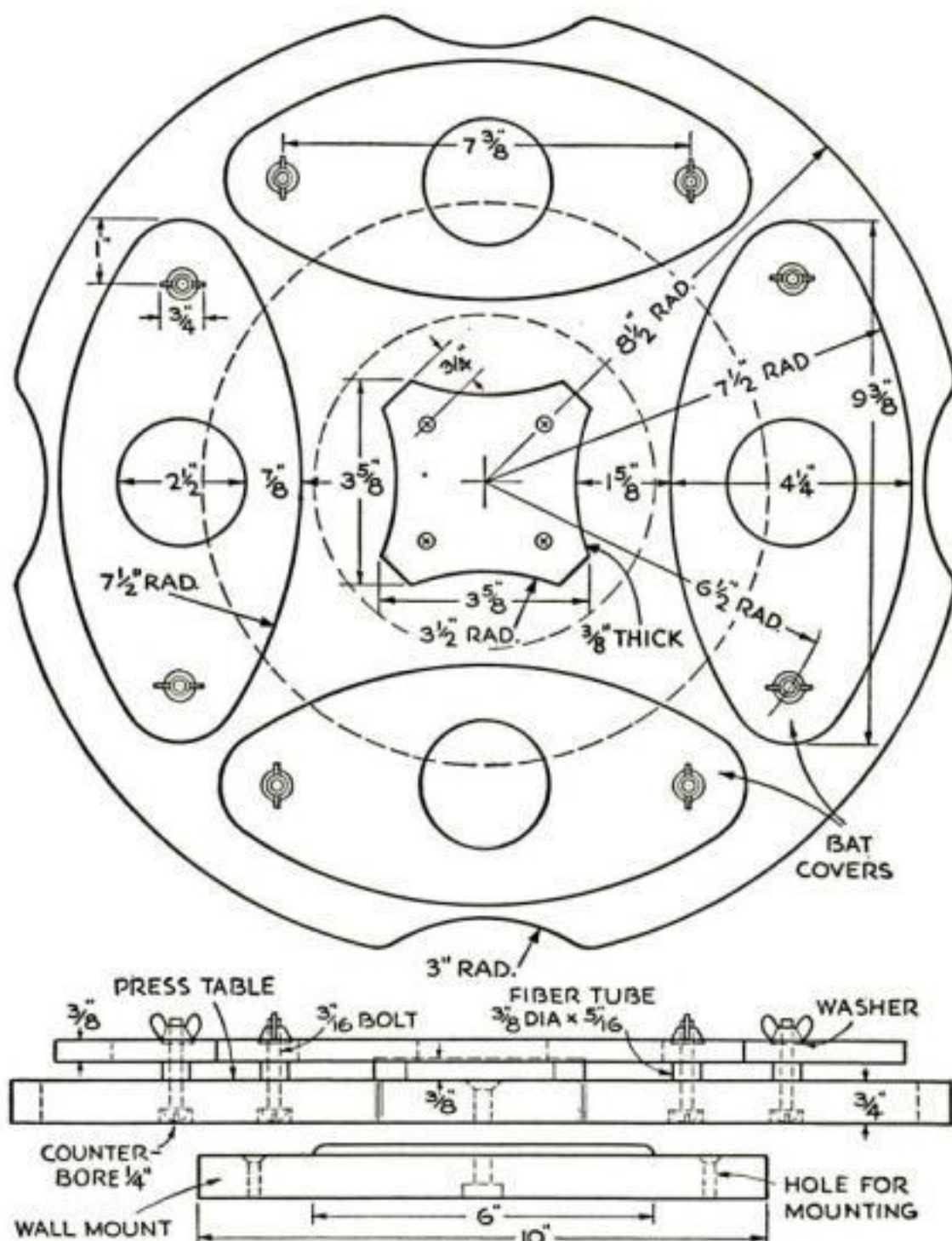


Projects

READERS BY CRAFTSMAN

Plywood is used for all the parts. The wall mount is either turned or built up of two pieces to form the shoulder. The table is 17" in diameter, with four semicircular cut-outs to clear the bat handles. Space $\frac{3}{16}$ " by $1\frac{5}{8}$ " clamping bolts on a $6\frac{1}{2}$ " radius, and slip $\frac{5}{16}$ " lengths of fiber tubing or drilled dowel over them before mounting the press plates. These are cut from $\frac{3}{8}$ " plywood, as is the centerpiece. Use small washers under the wing nuts.

A simple modern finish is obtained by rubbing white paint into the wall mount and the table; when dry, apply two coats of white shellac. In the original, the press plates and centerpiece were finished with flat black paint. Approximate working time, 6 hours.



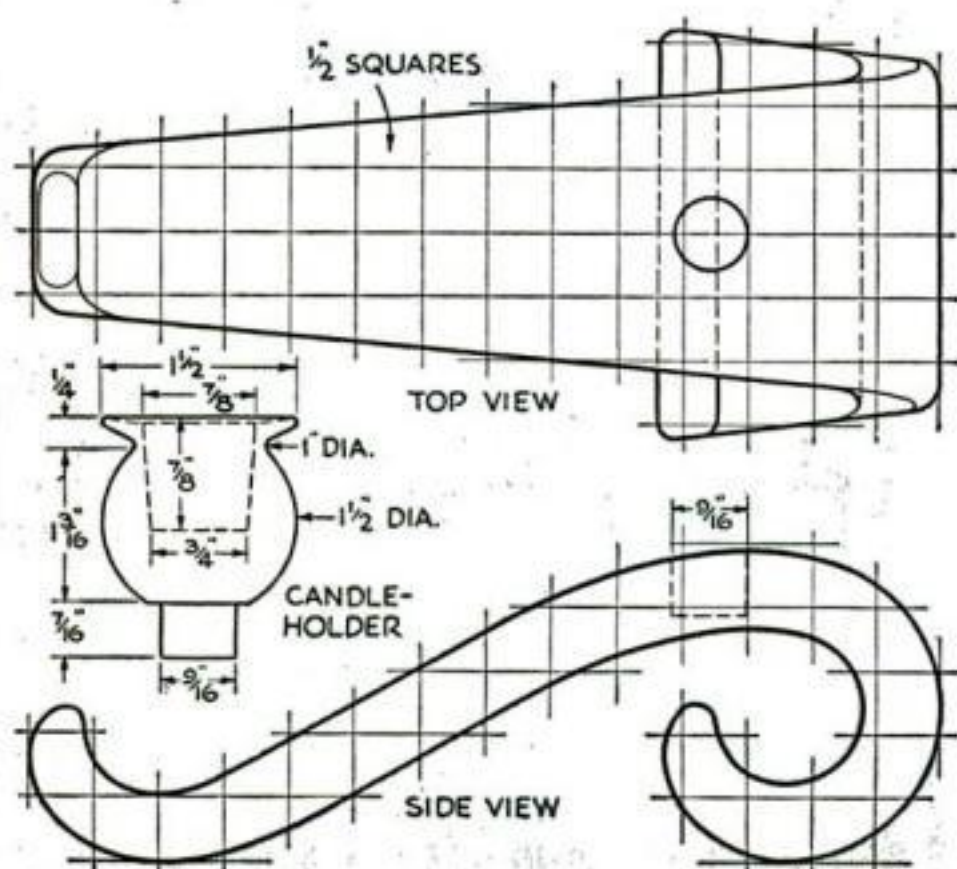


Scroll Candleholders ARE UNUSUAL CRAFTWORK PROJECTS

A PAIR of graceful candleholders like the one illustrated will lend a charming touch to almost any decorating scheme. They can be band-sawed to shape from two blocks of walnut $2\frac{1}{2}$ " by $3\frac{1}{8}$ " by 7".

Transfer the side view by means of $\frac{1}{2}$ " squares, saw out this profile, and carefully cut to the tapered form shown in the top view. Bore a $\frac{9}{16}$ " hole at the uppermost point for a turned holder of the same material as the base.

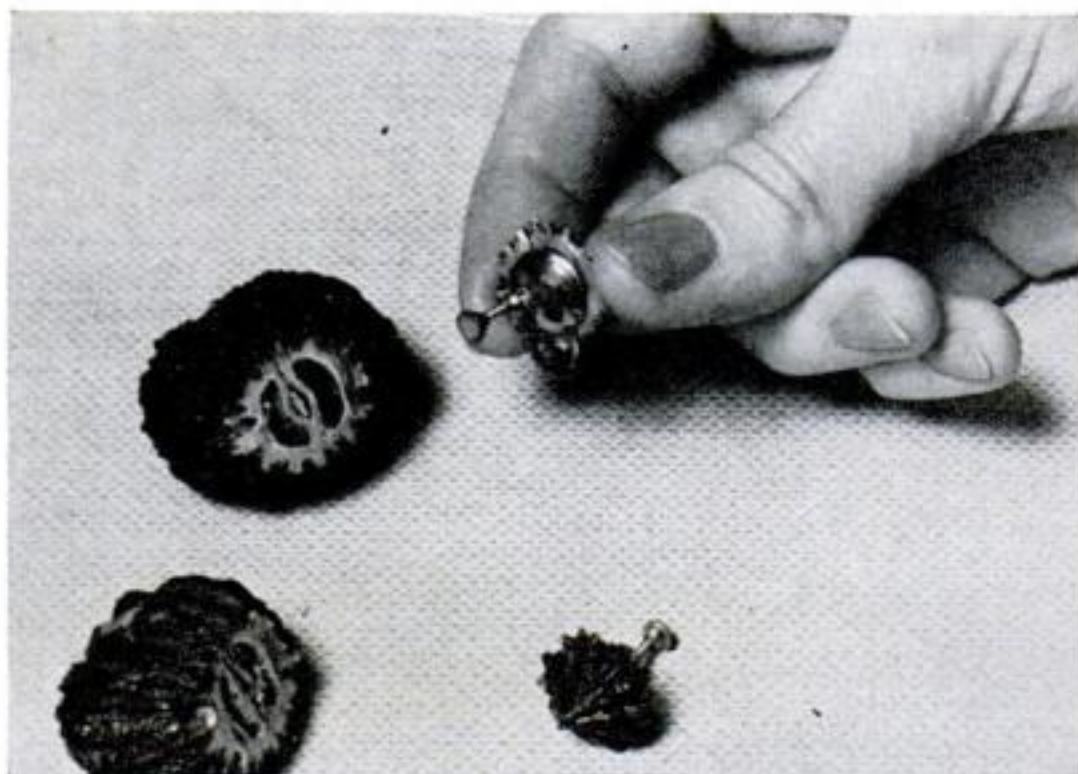
Round all corners and edges, sand smooth, and glue in the holder. Finish with stain, filler, and either varnish or shellac and wax, or in any preferred manner.—B. N.

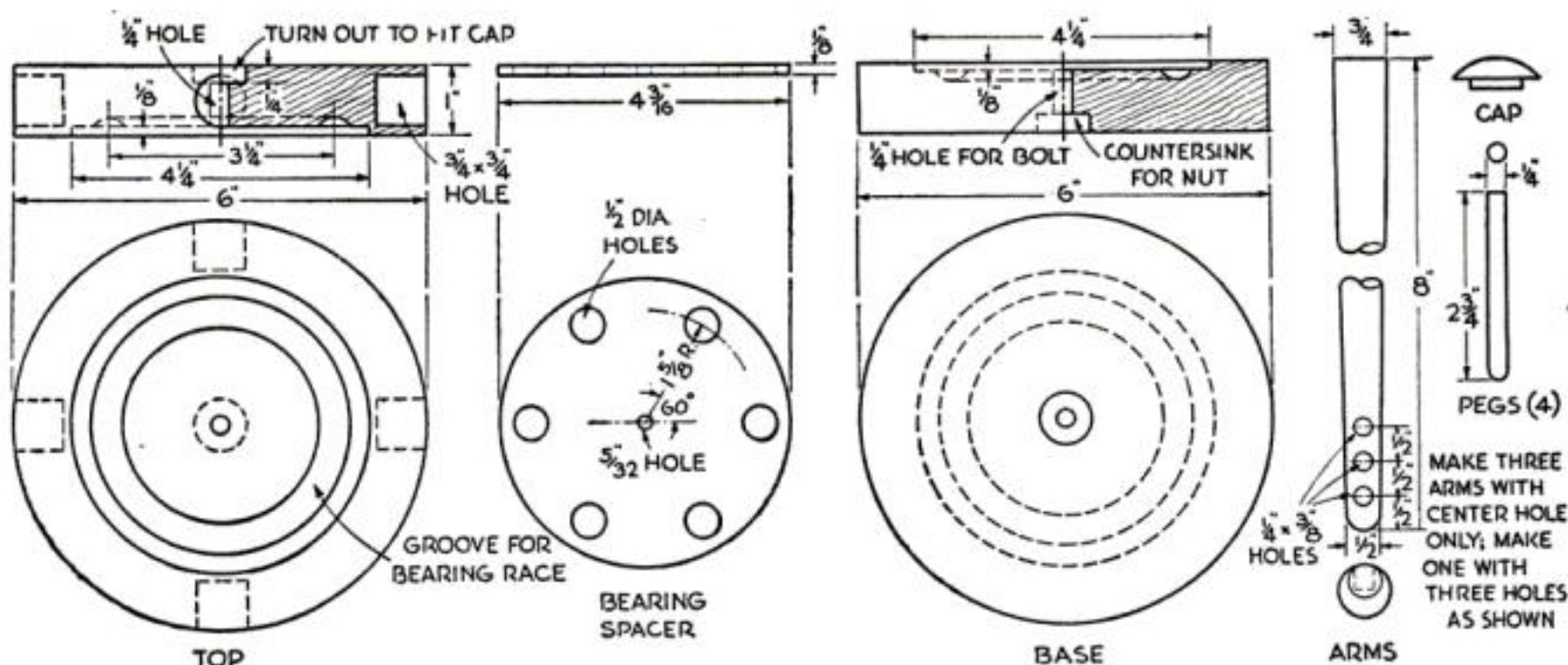


Walnut takes a desirable finish that sets off these candleholders well, but another wood might be used. Close-grained, sound pieces are essential to avoid danger of splitting across the short-grained portion

Novel Ornaments for Earrings Cut from Black Walnuts

THESE attractive novelty earrings were made from the tips of black walnuts. The screw clips can be obtained from an old, discarded pair of earrings, or a new set can be bought at the ten-cent store and the ornaments removed from them with a knife or a small pair of pliers. The tip ends are first cut from two walnuts, and then are cleaned thoroughly with a small, stiff-bristled brush. Next, a coat of clear, quick-drying varnish is applied to the tips, and they are allowed to dry for a short while. They can then be fastened securely to the clips with any good liquid cement.





For Knitters...

A BALL-BEARING YARN REEL



KNITTERS and knitting everywhere! If ever there was a season dedicated to knitting, this winter is going to be one, so there could be no better time to make a

few knitting accessories in your home workshop. First, of course, comes a knitting box or stand of some sort, and two designs have been suggested in a preceding article (pages 178 and 179). Next in importance is a yarn reel to hold a skein of wool.

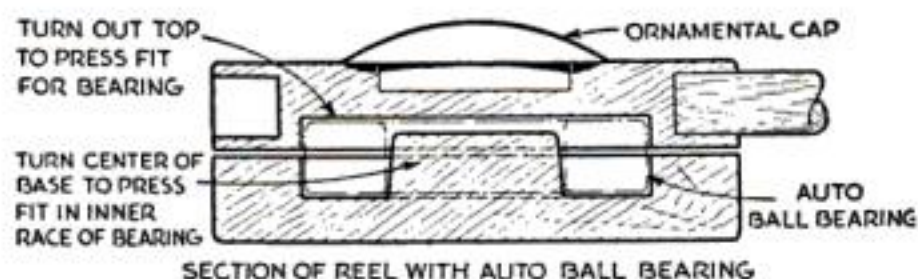
The primary purpose of a reel is to hold a skein while the yarn is being wound into a ball. If, however, a knitter works in one place and does not wish to carry her knitting around, she can save the time required for winding the yarn into a ball and draw it directly from the reel, but it is essential in this case that the reel be neatly made and nicely finished.

If a large discarded automobile ball bearing can be obtained, it is necessary only to turn two 6" disks to be a press fit inside and over the bearing respectively, as the lower drawing shows, and to fit the four arms and a decorative cap. A heavy bearing offers just the right resistance to the unwinding of the yarn.

Not as simple, but perhaps more novel, is the use of common glass marbles as bearing balls. Buy a bag of marbles and sort them to find six of exactly the same size. Turn the top and base from mahogany, maple, or other hardwood, making the bearing races exactly the same diameter and width in both parts. Drill four 3/4" holes in the edge



Operating on ball bearings, the reel will turn as the yarn is pulled either for winding or knitting

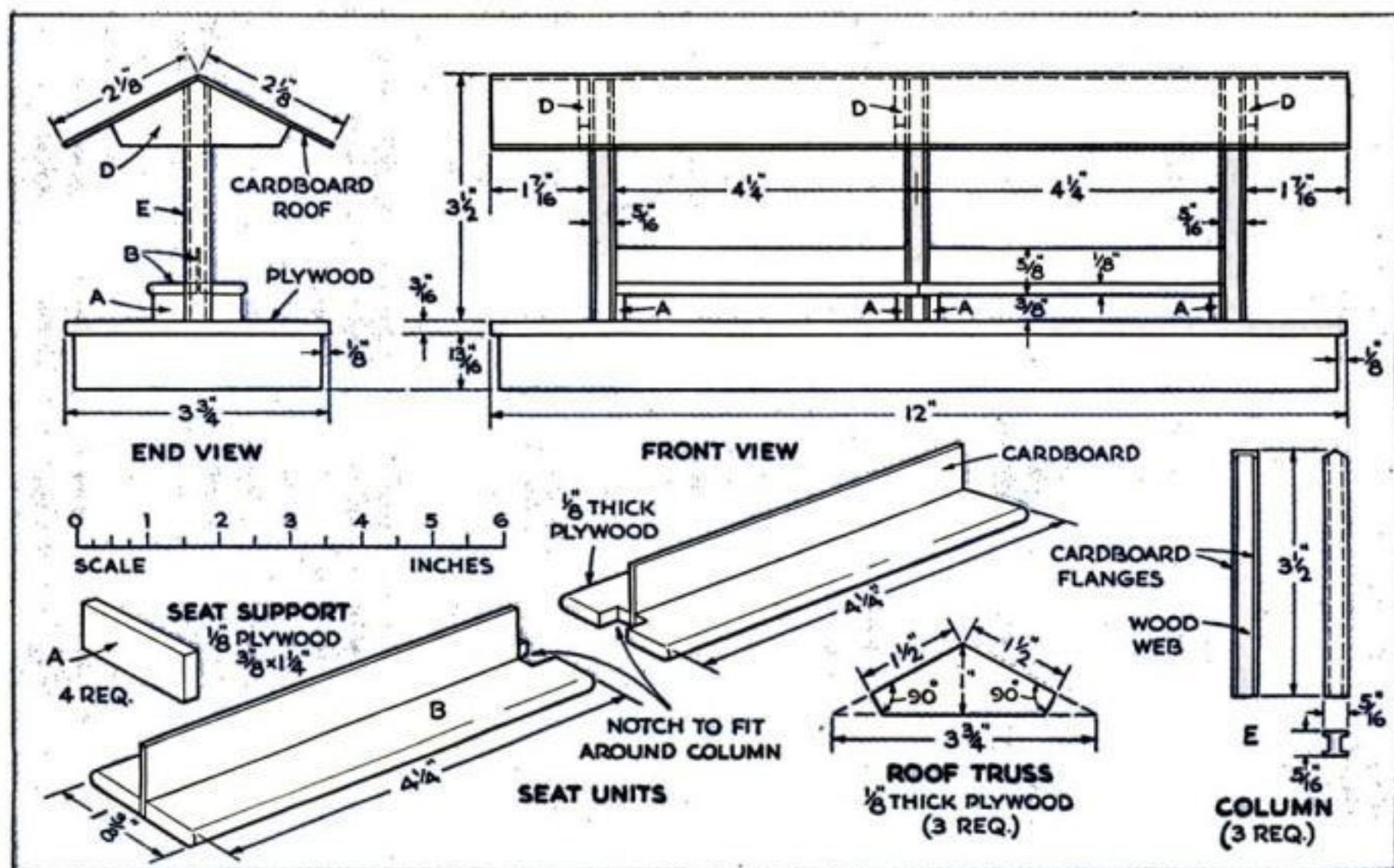


How the hub is turned to receive a ball bearing. Top of page, a plan to follow if marbles are used

of the top disk for the arms, one of which is made with three peg holes so that skeins of various sizes may be held. The other three arms have one hole each.

The bearing spacer is of 1/8" thick plywood. Drill six equally spaced holes in it slightly larger than the marbles. Assemble the reel with a 1/4" bolt to hold the parts together and press the turned cap in place to cover the bolthead.

The pegs are cut from maple doweling or, if a mahogany reel is being made, may be shaped from mahogany by hand. Finish the exterior parts of the reel with varnish or shellac, rubbed down and well waxed, or by any preferred method.—K. D. SPRAGUE.



Small Stations for a Model-Railway Layout

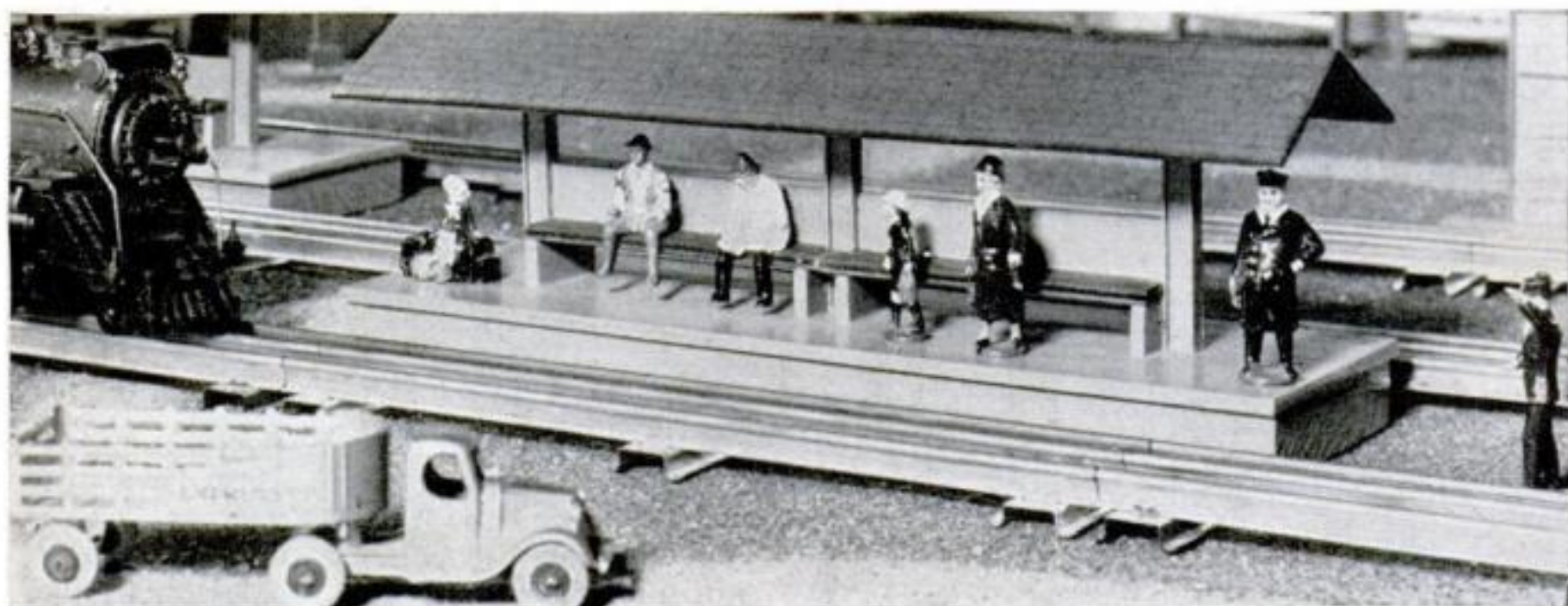
NO MODEL-RAILWAY layout is complete without one so-called "through passenger station" or passing station located somewhere between the main terminals. The design of the station illustrated, which is intended for "O" gauge, was adapted from an actual structure as a symmetrical unit so that two or more may be placed together to form a station as long as desired. Stations can also be placed on both sides of the track at an important stop. The dimensions may be altered to suit layouts in other scales as explained on the facing page.

Cut the roof from heavy cardboard, dye it with walnut water stain, and draw black lines on one side with a ruling pen to represent shingles. The roof columns are built up from thin wood and cardboard strips, ce-

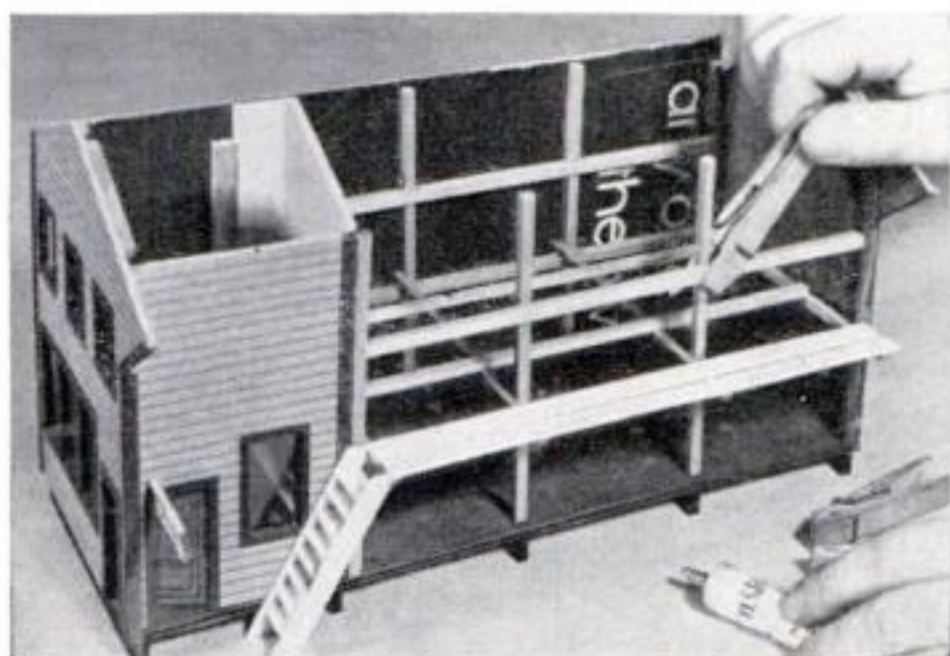
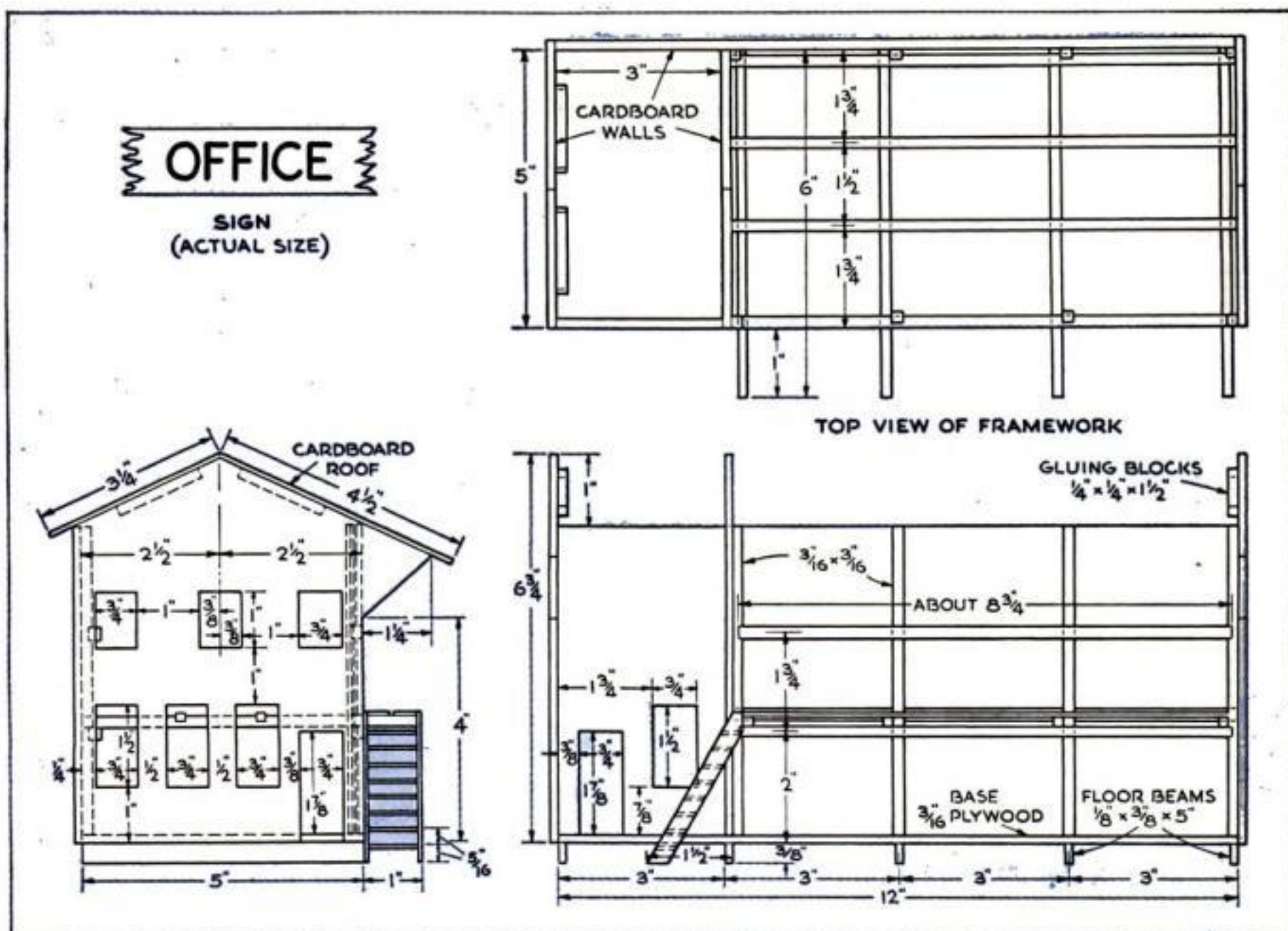
mented together, to simulate steel I-beams. The platform base may be solid or built up from cigar-box wood or plywood.

Using model-airplane cement and spring clothespins to hold the parts together while the cement is drying, fasten all seat supports and roof trusses to the columns as indicated. Notch the seats to fit around the center column and cement them to the cardboard seat backs. When the adhesive has set, cement both seat units between the columns to the seat supports. Center this assembly on the base. Then cement the two roof pieces to the trusses.

Columns and roof trusses may be painted gray; seats and supports brown or green. Small electric lamps installed under the roof will add much to the realism of the station.



Trackside Lumber Shed Enlivens Model Scene



FEW accessories will add more to the appearance of your railway layout than this realistic lumber shed, which is scaled to "O" gauge. For "HO" gauge, halve the dimensions given; for "OO" gauge, make them one fourth larger than for "HO."

Draw walls, windows, and doors on heavy cardboard, cut out with a sharp knife and steel straightedge, and tint these parts a light brown with water colors or oil stain. Rule black lines $\frac{1}{4}$ " apart (for "O" gauge) to simulate clapboard siding. Cement clear cellulose material over the window openings. Doors can be made of thin brown cardboard, ruled in imitation of panels, and glued by one edge inside the walls.

Saw the 5" by 12" base from plywood and glue the five floor beams to it. Cement the walls to the base and to each other along their vertical edges. Note that the front wall rests on top of the base, but the others are cemented to the sides of the base. The lumber rack consists of $\frac{3}{16}$ " square wood strips. Four of the crosspieces extend 1" from the face of the shed to support the board walk. Uprights and stringers at the front are notched where they cross. Make the ladder of cardboard and cement it on.

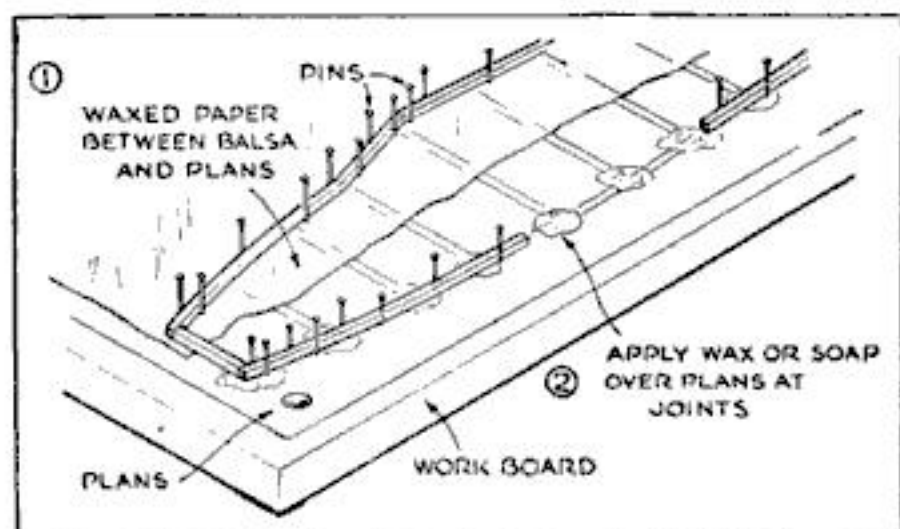
Windows and doorways are framed with

thin brown cardboard strips $\frac{1}{8}$ " wide, and $\frac{1}{4}$ " wide strips are cemented at the corners of the shed for trim. Cut the two roof pieces from $\frac{1}{16}$ " thick cardboard. Carefully rule on lines to represent shingles; then cement the two roof pieces in place.

The fence consists of four horizontal wood

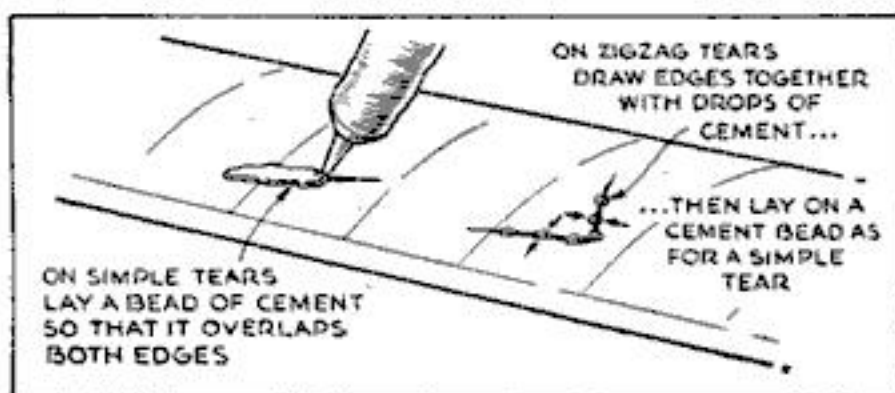
strips, $\frac{1}{16}$ " thick and $\frac{5}{16}$ " wide, glued to upright posts set 4" apart. Stain it brown to match the shed. The "office" sign can be traced off on cardboard and glued to a match stick inserted in a hole above the door. Be sure to rip plenty of "lumber" of various sizes to stock the shed.—C. E. BLACK.

Practical Pointers on Building and Repairing Model Planes

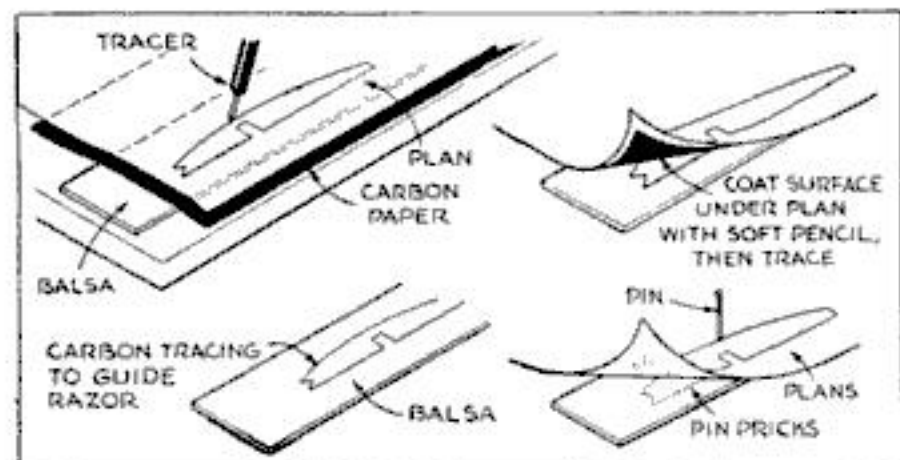


WHEN VARIOUS UNITS of a model airplane are constructed directly over the full-size plan, the parts will stick to it, and the drawings have to be torn to remove the work. To prevent this, either use wax paper between the work and the plan, or coat the latter with soap or wax at each place a joint is indicated. Remember that cement next to the plan does not set as soon as that on top because it is less exposed to the air; therefore allow some time to elapse after removing the work to let all the cement harden.

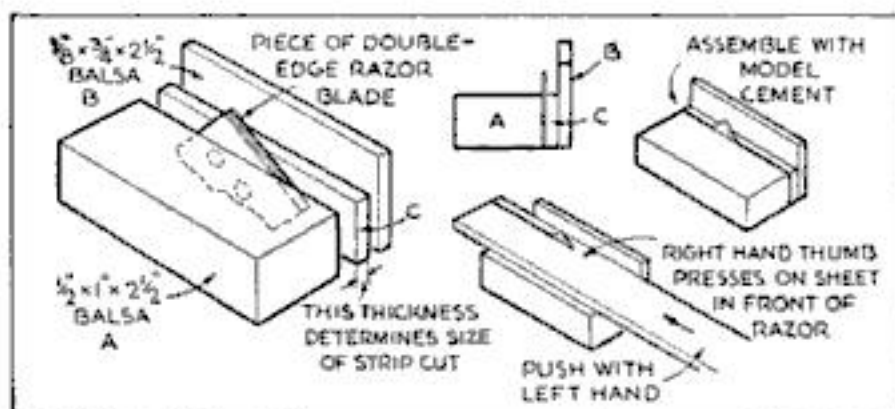
IF THE COVERING of a model airplane becomes torn, temporary or even permanent repairs can often be made with cement. When the tear is a simple one, apply a continuous bead of cement so that it overlaps both edges. This will usually draw the edges together



and remove the wrinkles. For a zigzag tear, draw the edges together with a few spots of cement, then apply a continuous bead of cement over them. Edges that are not in line can be pulled together with the end of a pin.

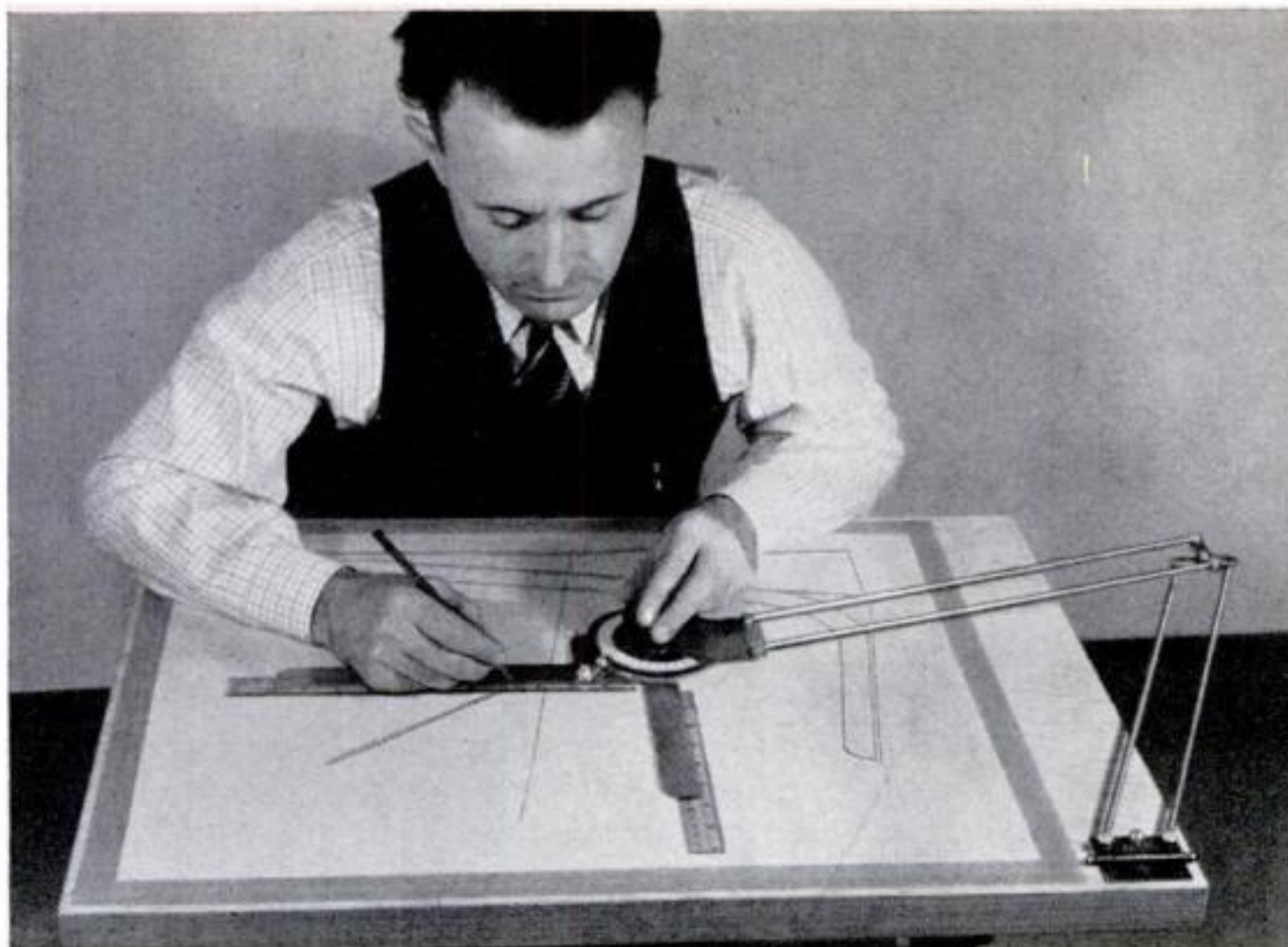


THERE ARE SEVERAL good ways to transfer outlines from drawings or printed plans to the stock from which parts are to be cut. If the plan is in a magazine or book and it is desired to avoid cutting or marking the pages, use carbon paper and a pointed tracer. Ordinarily, however, it may be found more convenient simply to blacken the undersurface of the plan with a soft lead pencil, and trace through with a pointed instrument or a very hard pencil. Another very accurate and often faster method is to prick through the outline into the wood at intervals with a pin or a mounted phonograph needle.



IN CONSTRUCTING model airplanes or other models in which strips of balsa wood are used, it is important to have several balsa strippers or cutters of different sizes. These can easily be made as shown above. They will cut all grades of balsa except that known as "rock hard." The strippers are especially useful when one has to order supplies by mail and cannot foretell just what width strips will be required.

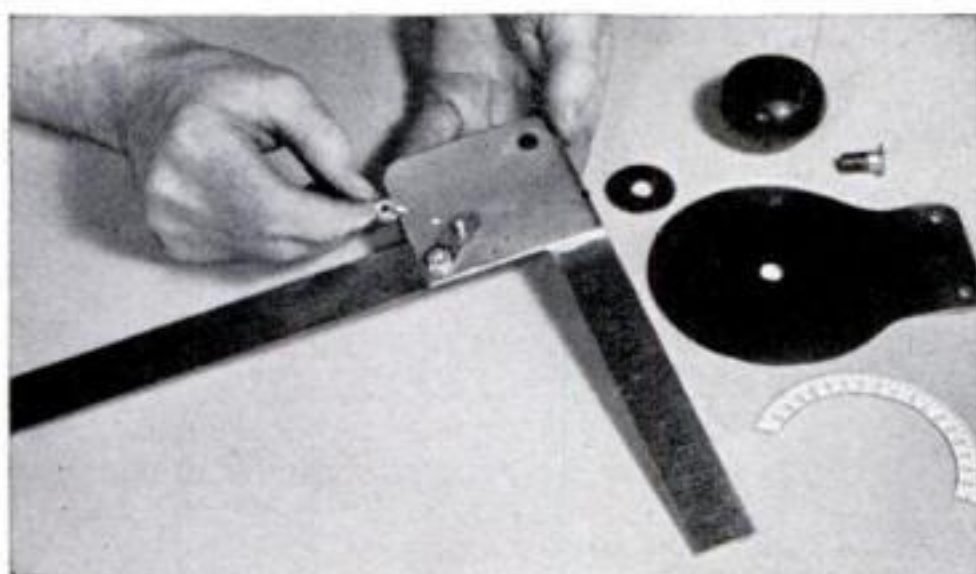
APPLYING COLORED DOPE. Use several thin coats rather than one or two thick ones. Dope and brush should be of first-class quality. Keep cement off surfaces finished with colored dope; it will not hold well, and it loosens the color.—FRANK ZAIC.



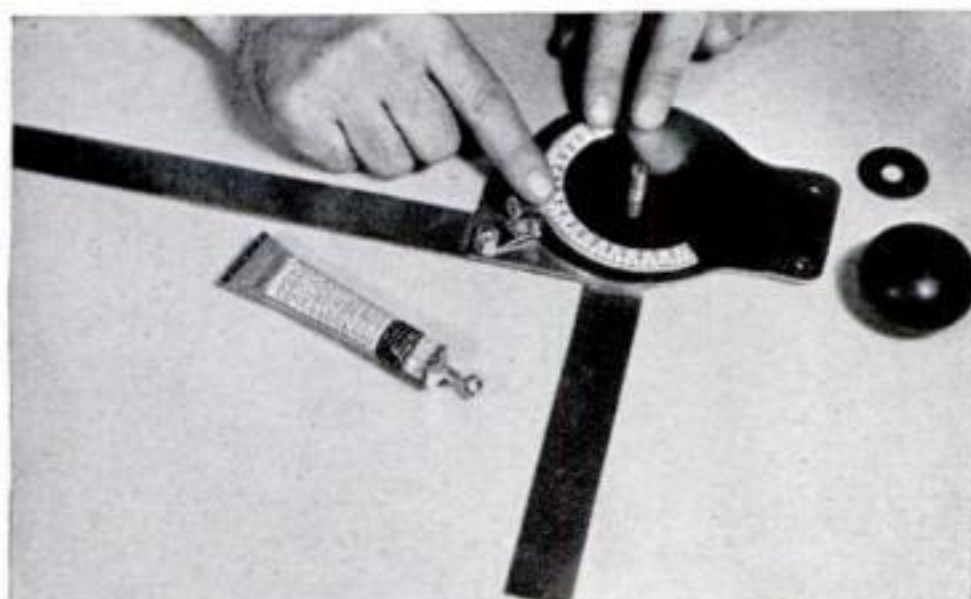
No scales, triangles, T-square, or protractor is required when making drawings with this simple, practical drafting machine, and the work can be done in 40 to 50 percent less time. The square remains at a constant angle wherever it is placed on the board, and it can be set to any protractor reading

Homemade Drafting Machine

By L. C. PELTIER



First, solder a sheet-metal plate to the square. Note hole for pivot bolt, and clamping lug in the lowest corner. Upper plate appears at right above



Bevel the clamping lug and scratch a line on it as an indicator for the protractor, which can be fastened to the upper plate with cellulose cement

A DRAFTING machine is a parallel-ruling machine which, by combining several of the most frequently used drawing tools in one instrument, enables a greatly simplified drafting technique to be employed.

For practice work and ordinary shop drafting, a satisfactory machine can be made almost entirely from materials found in five-and-ten-cent stores. The machine illustrated consists of a ten-cent steel square, two celluloid rulers, a celluloid protractor, four tubular curtain rods, and a hinge, all from the "five-and-ten"; a gear-shift knob from a junk yard; a couple of pieces of sheet metal, and sundry screws, washers, and rivets. Dimensions are governed largely by the parts used and are not critical except in a few respects, which will be mentioned later.

A small plate of about 18-gauge sheet metal is soldered to the steel square as shown. Near one corner of this piece a $5/16$ " hole is drilled to receive the control-knob bolt. The larger upper plate, which is circular with a rectangular projection at one side, serves as a mounting piece for the parallel arms and the protractor. Cut it to shape and drill a hole in its center for the control-knob bolt. Inasmuch as the instrument will pivot on this bolt when turned for laying out angles, both holes must be drilled to a very close fit to insure accuracy.

A $5/16$ "-18 cap screw was used for the

HOW TO LEARN PROFESSIONAL DRAFTING TECHNIQUE

COUNTLESS mechanically minded men are studying drafting in order to advance themselves in the present upsurge of industrial mobilization. Most of them would like to gain experience in the use of the so-called "drafting machine," now universally found in large drafting rooms. First-class drafting machines are, of course, too expensive for the average man to purchase merely for practice work; besides, industry is using every available machine and all that can be manufactured.

A good solution has been worked out in this article by Mr. Peltier, who is himself an

expert draftsman, although better known as one of the world's foremost amateur astronomers. Mr. Peltier's suggestion is that students and mechanics make their own drafting machines. This can be done without much difficulty and at surprisingly low cost. While a handmade machine can hardly be expected to compare in accuracy or appearance with even medium-priced commercial machines, it will serve for practice work and ordinary drafting of the type done in small shops where a high degree of precision is not essential. The technique is the same as that required in using a commercial machine.

bolt as it happened to fit the threads in the gear-shift knob. The head of this cap screw is filed to about $1/16$ " in thickness so that it will clear the drawing. The two plates are clamped together by tightening the control knob, and also by a small clip of 18-gauge metal, which is bent to an offset equal to the thickness of the upper plate. A flathead stove bolt, countersunk flush on the underside, secures this clamp to the square. The clamping bolt, also countersunk, is fitted with a wing nut.

Round the outer corners of the steel square as shown. Cement the protractor to the upper plate, and cement the celluloid scales to the underside of the square, cutting one to 8" in length and notching the other to clear the screw heads. Inasmuch as cheap squares are none too accurate, it is best to check the scales against accurately drawn right-angle lines before the cement sets. Afterwards, the scales can be further secured with small flush tubular rivets.

The parallel arms, which are made from tubular curtain rods, are all cut to exactly the same length, which will depend upon the size of the drawings to be made. The arms shown are $16\frac{3}{4}$ " between rivet centers—more than ample for drawings 17" by 22".

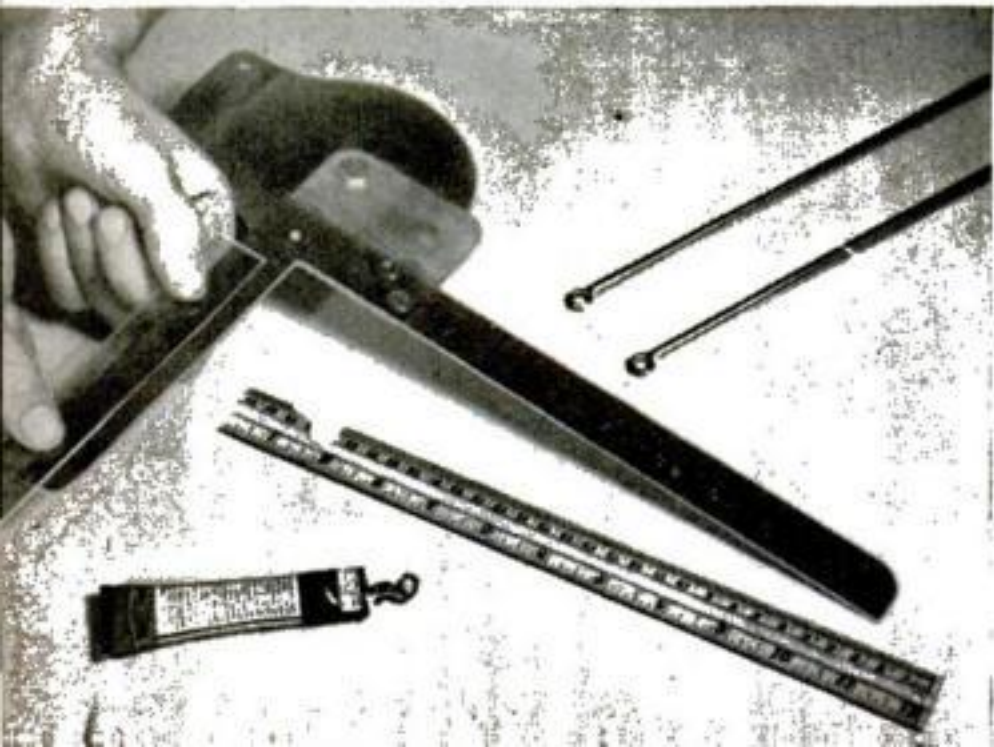
Cement the scales to the underside of the square at precisely a right angle. The arms are made by soldering screw eyes to the ends of curtain rods

It is best, although not essential, if these arms are of seamless tubing. Solder large screw eyes into both ends of each rod, taking care that both screw eyes on any rod lie in the same horizontal plane. They should be of a size to accommodate a solid rivet approximately $1/4$ " in diameter. Since the accuracy of the machine depends on the close fitting of these riveted ends, special care should be taken that the rivets are all drawn up fairly tight, with no excess play or lost motion. After the joints are riveted, a little oil on each will make all work smoothly.

The machine is fastened to the drawing board with a cabinet hinge having a fairly long and close-fitting pin. One leaf of the hinge is reversed to give clearance for the rivets. As the outer holes of the hinge happened to be $1\frac{7}{8}$ " apart in this case, both pairs of arms were spaced this distance apart. The center hole in the hinge leaf is tapped to receive a $1/4$ " stove bolt, which serves as an adjustable stop to keep the arm assembly from resting on the drawing board.

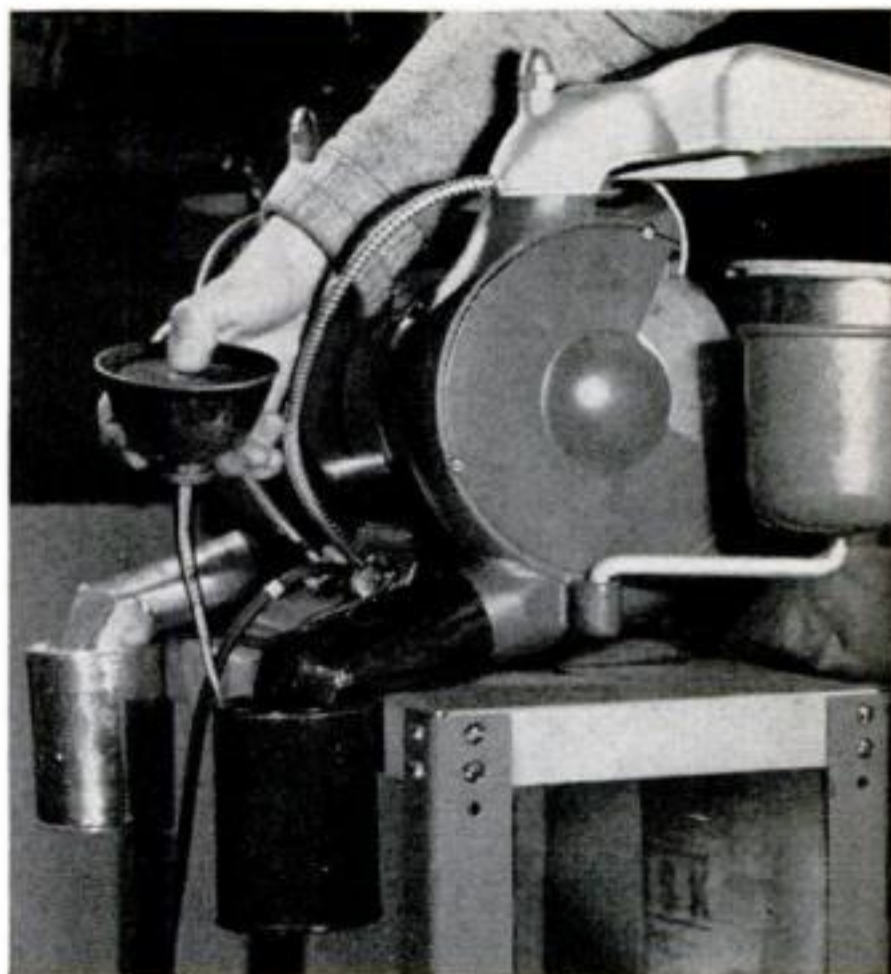
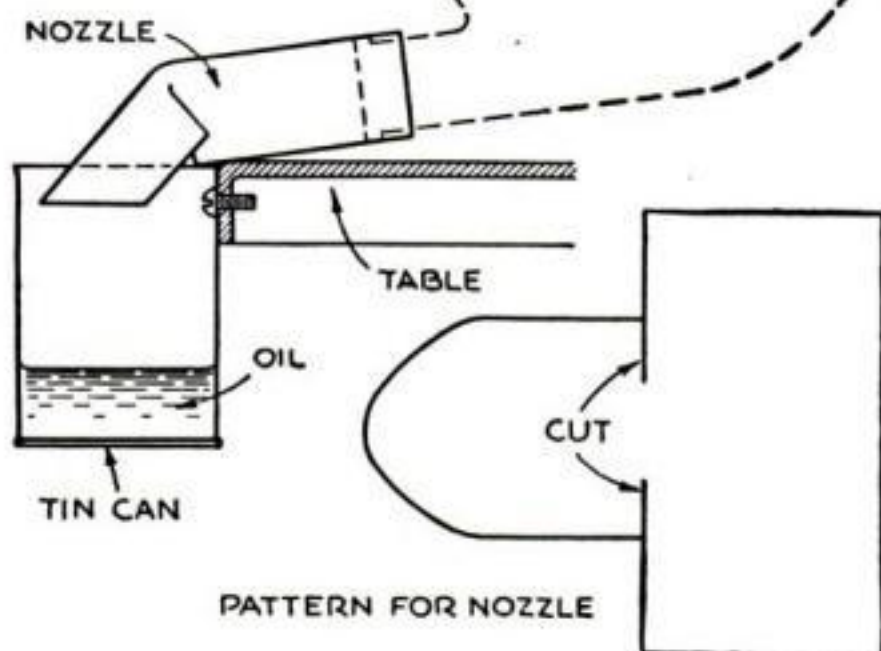
The elbow hinge consists of two strips of 16-gauge metal set at right angles, with a couple of washers between to serve as spacers. These pieces are riveted together to form a rigid unit.

The elbow joint is riveted and soldered at its middle. All other rivets must permit movement of the parallel arms, but without any excessive play



Tin Cans Catch Grit and Dust from Grinding Wheels

Both dust traps can be bolted to the edge of a grinder stand as shown. Cement sheet rubber inside the nozzle to shield it from the fast-flying particles



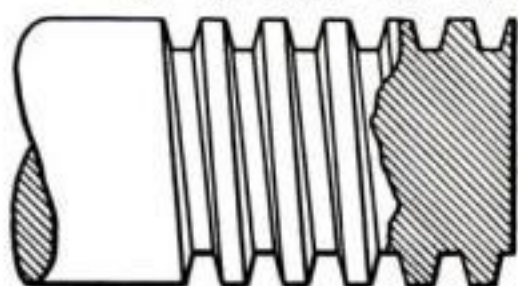
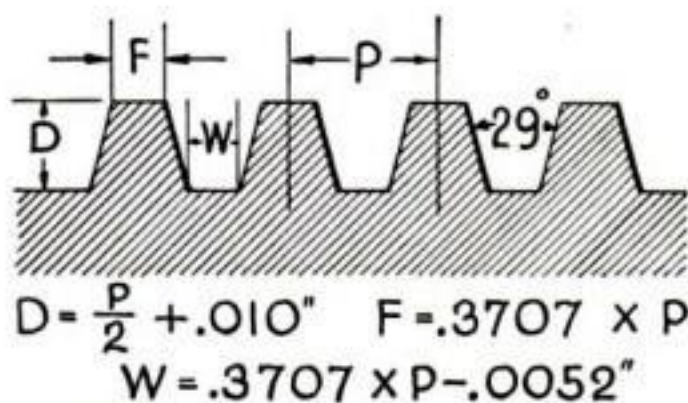
FOUR or five tin cans provide the material for an efficient dust catcher on a bench or pedestal grinder. Two cans, partly filled with automobile-engine oil, entrap and hold the gritty dust. The others furnish metal for making tubes or nozzles to carry the dust from the outlet openings in the wheel guards to the oil containers.

Mount two of the cans behind and somewhat below the dust outlets. On most grinders these are so shaped that a cloth bag or other dust catcher can be tied around them. When the grinder is on a steel stand,

the two cans are fastened by running a $\frac{1}{4}$ " or $\frac{3}{8}$ " bolt through a hole near the top of each and into tapped holes in the edge of the stand.

Shape the connecting tubes so they will slip over the dust outlets, with their outer ends curving down into the oil reservoirs. To prevent the grit from sand-blasting the inside surfaces of the tubes where they curve downward, apply adhesive tape or a thin sheet of rubber. Into the oil reservoirs pour about 1" of moderately heavy oil. Empty whenever dust accumulates.—W.E.B.

ACME SCREW THREADS AND FORMULA [LATHE WORK—23]

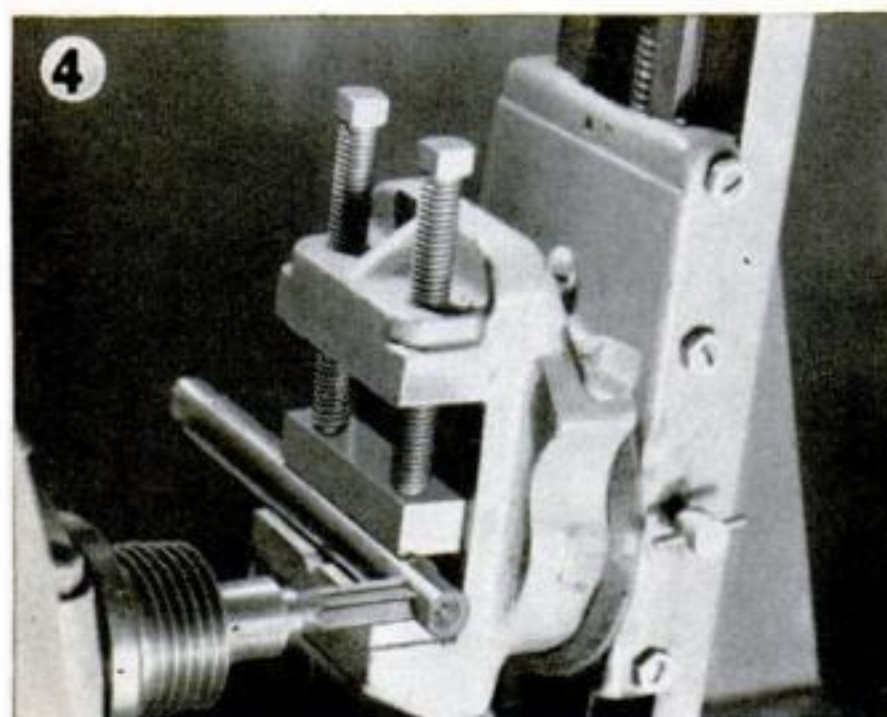
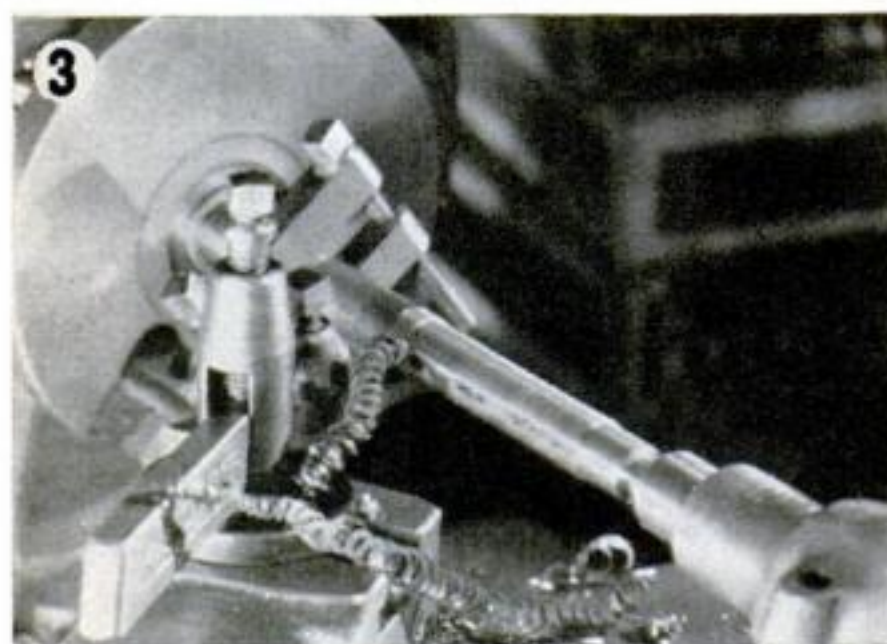
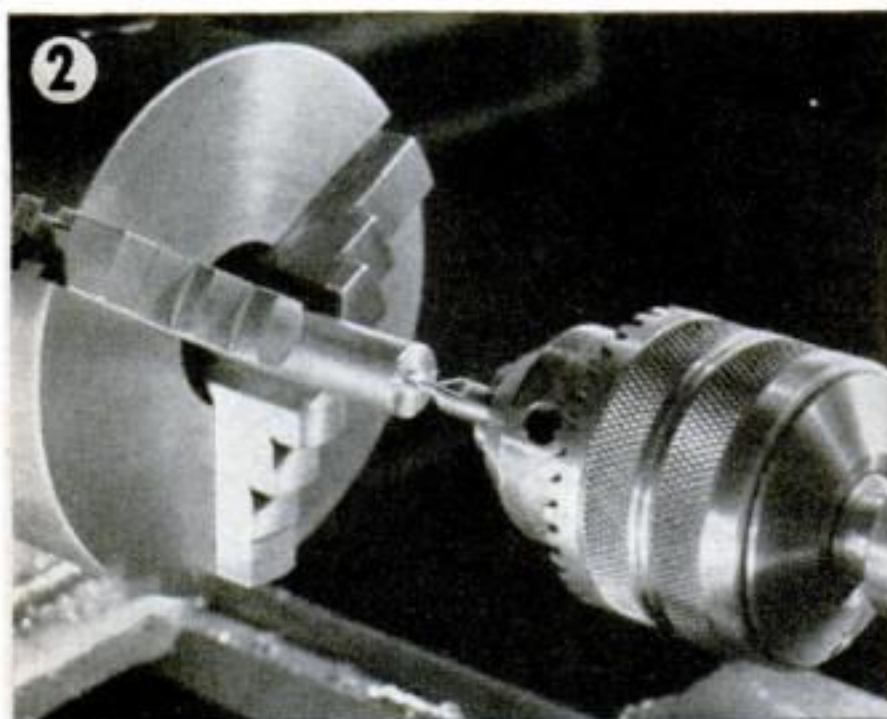
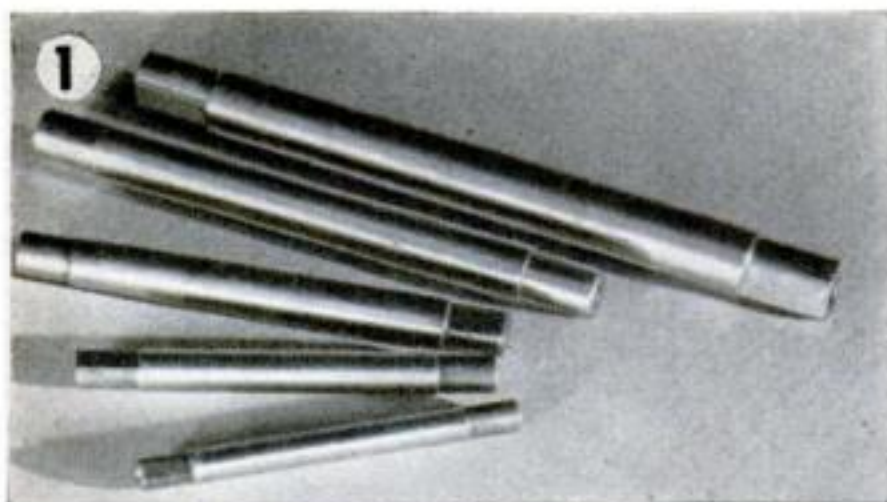


The Acme thread is used extensively for feed and adjusting screws on machinery, and is replacing the square thread in many instances because it is easier to cut. The included angle between the sides is 29 deg. As the accompanying formula shows, the depth is made equal to one half of the pitch plus 0.010" in order to provide clearance between the top of the screw thread and the bottom of the thread groove in the nut.

Cutting an Acme thread is similar to cutting a 60-deg. type thread. The tool must be set at 90 deg. to the work with an Acme thread gauge. However, lighter cuts are taken than when cutting 60-deg. type threads, because the total cutting face of the tool is longer.

POPULAR SCIENCE MONTHLY SHOP DATA FILE

MACHINISTS



How to Make Lathe Mandrels

A SET of mandrels such as shown in Fig. 1 is a good practice project for beginners in machine-shop work. Cut tool-steel stock to length and centerdrill it as in Fig. 2. This must be done with the utmost accuracy since it is necessary that the outer shell left from the rolling process be uniformly turned off. Mount between centers and rough-turn as in Fig. 3. The piece is then pack annealed to eliminate any internal stresses. Replace it in the lathe and bring it to size with several light cuts, leaving it about 0.002" oversize to allow for grinding afterwards.

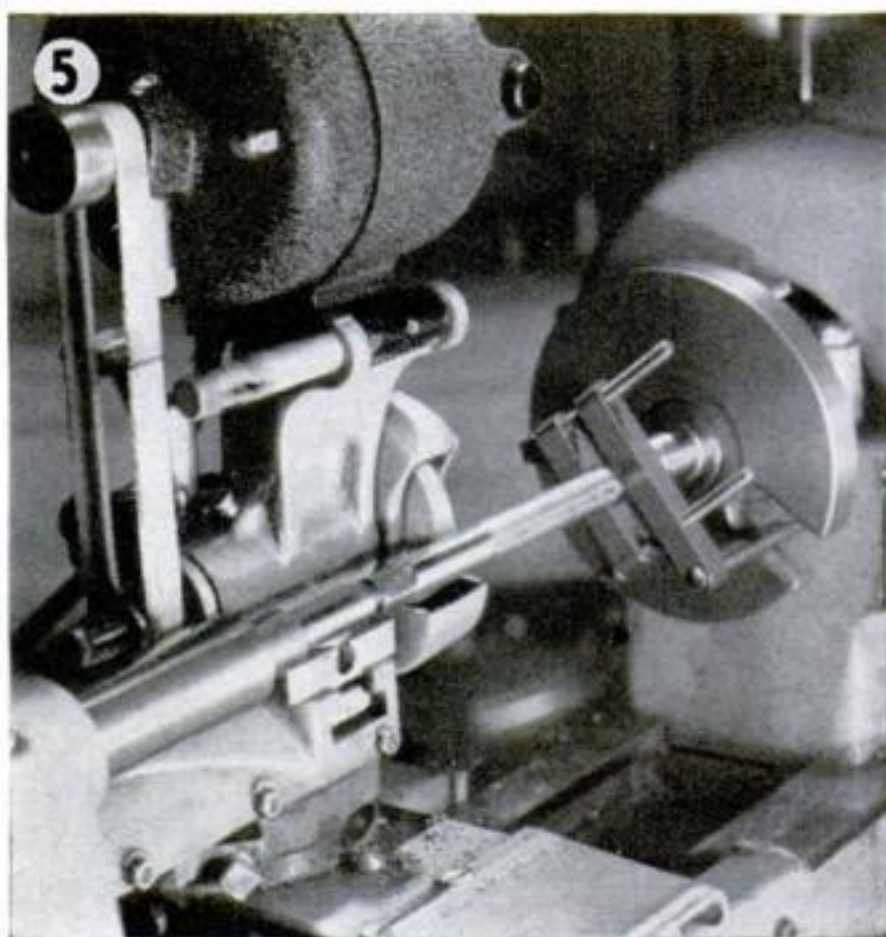
Ream and counterbore the holes in the ends very carefully, as the accuracy of the mandrel depends upon their being concentric with the outer diameter. The flat on each end for the set screw of the lathe dog can be carefully filed or cut with an end mill as in Fig. 4.

Mandrels are usually tapered 0.006" per foot and always have the size stamped on the large end. After it has been marked thus, the mandrel can be hardened and tempered, then mounted between centers and ground to the proper taper and final size with the tool-post grinder as in Fig. 5.

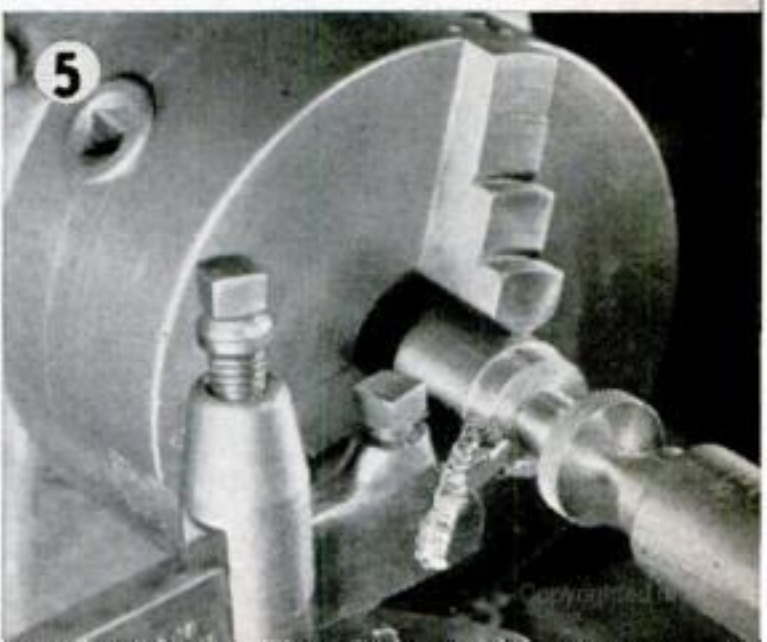
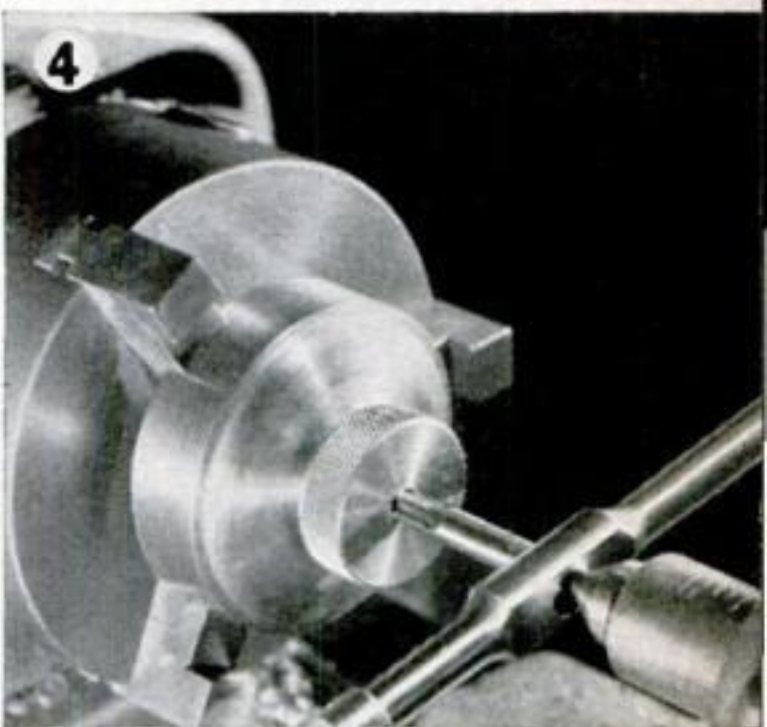
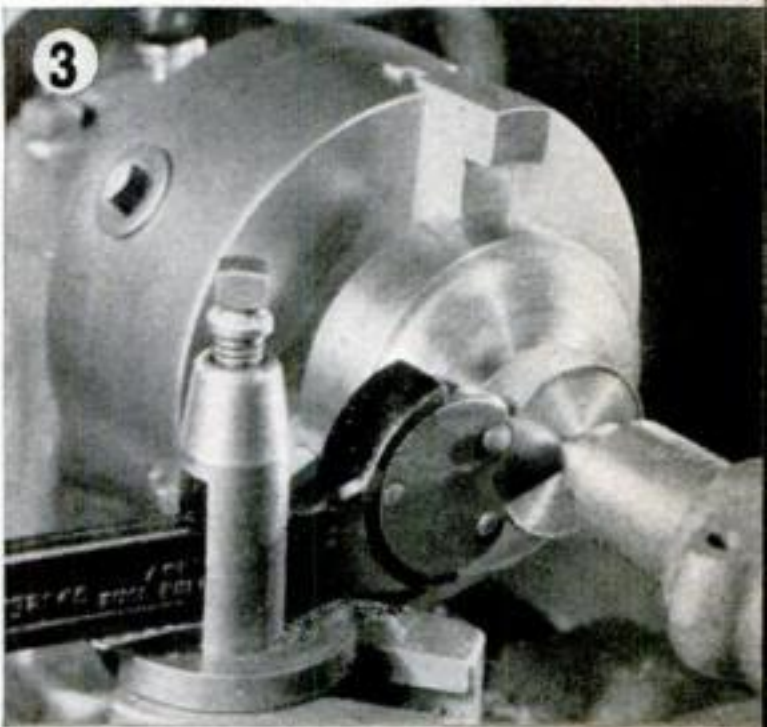
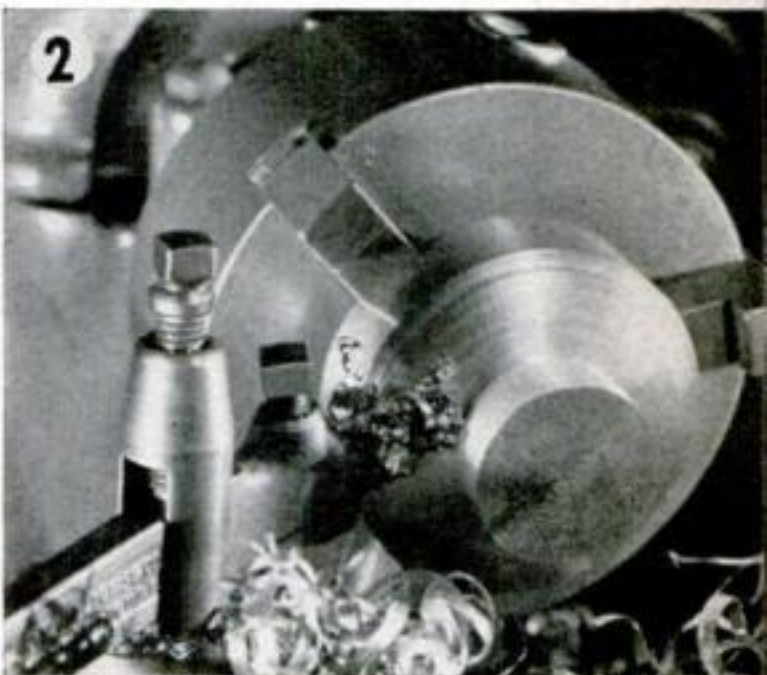
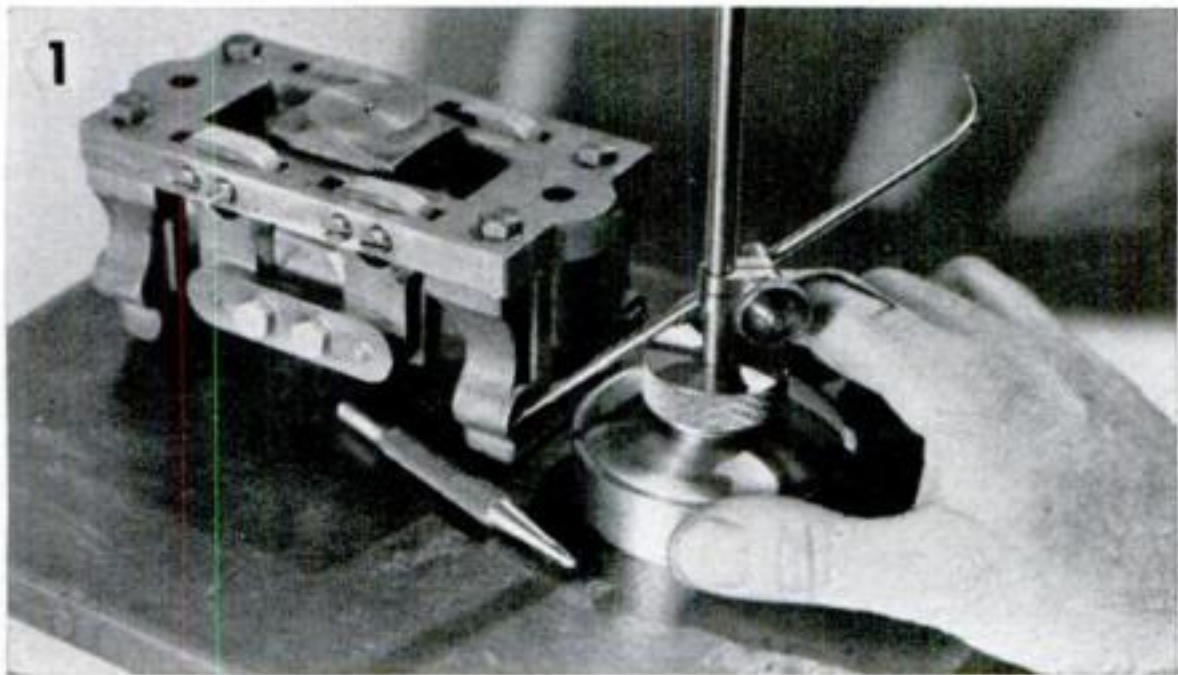
Constructing a Surface Gauge

COLD-ROLLED steel was used for the base, and drill rod for the spindle and scribe of the surface gauge (Fig. 1 on the facing page).

Chuck the base stock and turn it (Fig. 2) to the dimensions in the drawings; next



FOR DEFENSE

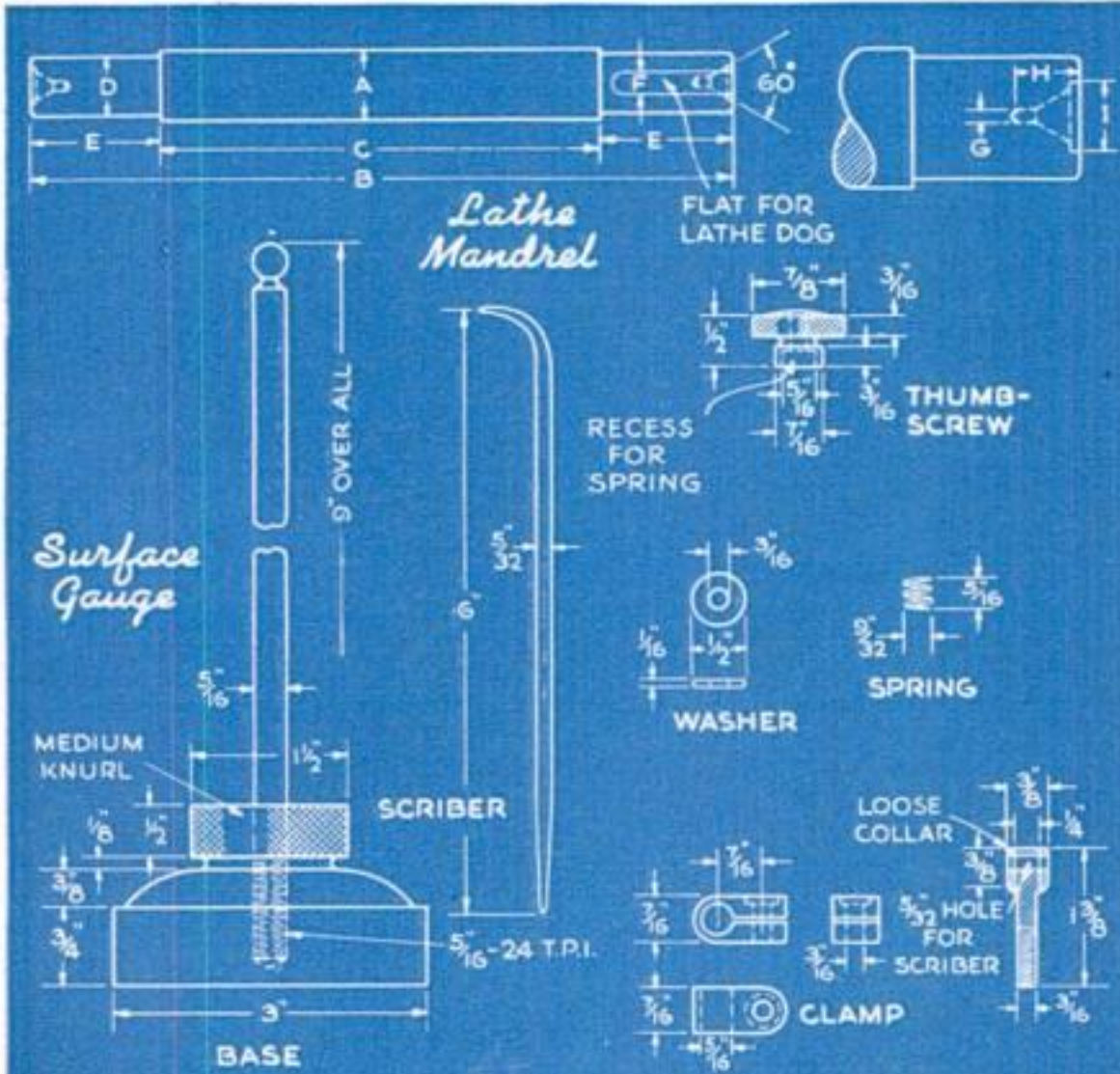


drill a center hole for tail-stock support and knurl the knob (Fig. 3). The piece is then centerdrilled 0.272" and tapped 5/16"-24 in the lathe, as shown in Fig. 4.

Turn the knurled thumbscrew from solid bar stock (Fig. 5), drill and tap it 3/16"-24 and cut it off. Make the clamp assembly from mild steel. Turn both spindle and scriber from drill rod in the lathe. The spindle is threaded on one end to fit the base. After bending the scriber to shape, harden and temper the points. Note that the scriber passes through a hole in a loose collar slipped over the clamping screw. A wedging action clamps the scriber in any position when the thumbscrew is tightened. Use the gauge on a surface plate as in Fig. 1.—C. W. WOODSON.

DIMENSIONS FOR SOLID LATHE MANDRELS

A	B	C	D	E	F	G	H	I
1 1/4	4	2 3/8	7/32	13/16	5/64	.046	1/8	3/16
5/16	4 1/4	2-9/16	9/32	27/32	3/32	.052	5/32	13/64
3/8	4 1/2	2 3/4	11/32	7/8	1/4	.055	3/16	7/32
7/16	4 3/4	2-15/16	3/8	29/32	9/64	.059	7/32	15/64
1 1/2	5	3 1/8	7/16	15/16	5/32	.063	1/4	1/4
5/8	5 1/2	3 1/2	9/16	1	3/16	.073	5/16	9/32
3/4	6	3 7/8	21/32	1-1/16	15/64	.079	3/8	5/16
7/8	6 1/2	4 1/4	25/32	1 1/8	9/32	.089	7/16	11/32
1	7	4 5/8	7/8	1-3/16	5/16	.096	1/2	3/8



Lead Weights Stop Brake Drums from Vibrating in Lathe

MECHANICS are all familiar with the tool chatter encountered when turning brake drums on a lathe. Various methods of deadening the vibration of the drum while turning it are used, but most of these require some time to install, are too much like a makeshift in appearance to be tolerated in a good shop, or lack sufficient weight to do an efficient job.

The method illustrated avoids these difficulties and combines all the features desired, including ease of installation on the drum. Four lead blocks $\frac{1}{2}$ " by 2" by 6" are cast in a mold, with a piece of $\frac{1}{8}$ " welding rod extending lengthwise through each block far enough to enable a loop or hook to be bent at each end.

To each block a piece of heavy leather belting is fastened with countersunk rivets. The blocks are then bent into a slight arc to fit the outside diameter of the brake drums. Four medium-heavy pull springs are hooked



Four lead blocks are held on the brake drum by means of coil springs

into the loops of the welding rod of each block to hold them snugly to the drum while it is being turned. Just one end of one spring needs to be unhooked to remove the blocks from the drum, and the four blocks can be hung together on the tool board for use whenever needed.—E. S. HARRIS.

Ball-Bearing Spindle Designed for High-Speed Service

BOTH professional and amateur machinists may occasionally be required to construct spindles capable of running at 10,000 to 40,000 r.p.m., such as are used in tool-post grinders. However, designing such a spindle is not the simple matter it may appear at first glance. Even apparently sound construction may fail to stand up under continuous operation for long periods.

A well-designed spindle of this type is shown in the accompanying drawing. It is not difficult to make, but embodies all the essentials for satisfactory high-speed duty, and the dimensions can be changed as necessary to

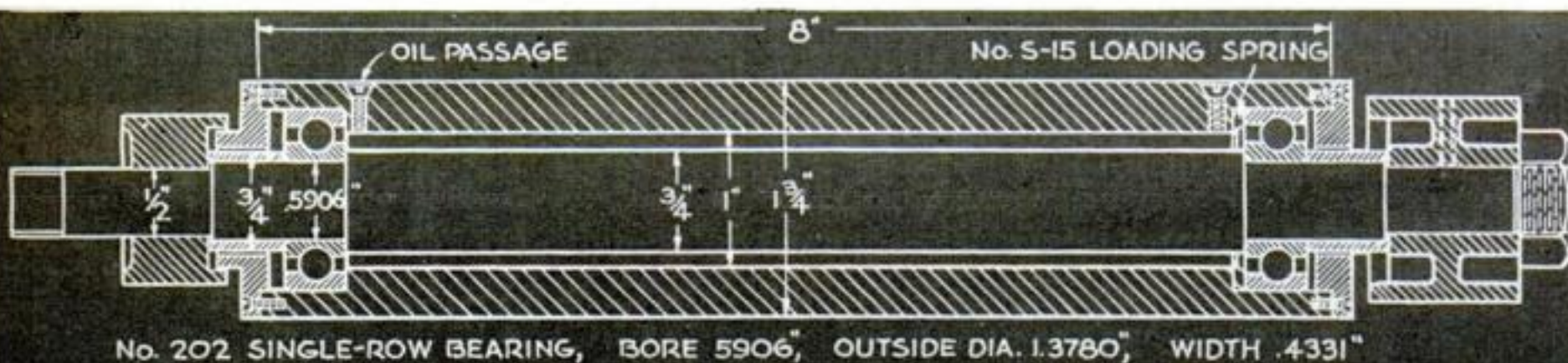
suit the requirements of any specific job.

As double-row ball bearings are not recommended for speeds higher than about 10,000 r.p.m., standard No. 202 single-row bearings are used. The spindle is of the preloaded type.

The housing is bored a snug fit for the bearings, but the recesses are deep enough to leave considerable clearance between bearings and end caps. End play is taken up and the spindle "loaded" by inserting a loading spring behind one bearing. Both ends of the spindle are provided with collars that bear against the inner bearing races. The end caps are bored with ample clearance for these collars.—M. MIDDLETON.



This spindle, of the so-called "preloaded" type, can be operated safely at speeds up to 40,000 r.p.m.



No. 202 SINGLE-ROW BEARING, BORE .5906", OUTSIDE DIA. 1.3780", WIDTH .4331"

Adjustable GROWLER

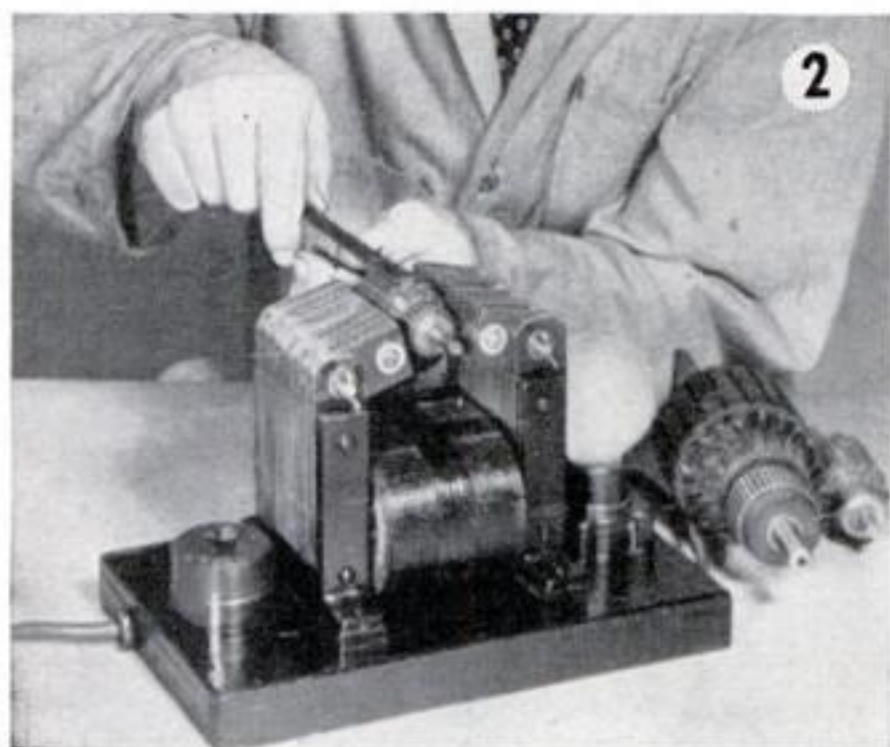
*Tests Large and
Small Armatures*

By HAROLD P. STRAND

FOR testing the armatures of vacuum-cleaner, electric-drill, or other commutator-type motors, "universal" fans and motor-driven kitchen appliances, and automobile starters and generators, what is called a "growler" is generally used. With this device it takes very little time to find a short-circuited coil, a "short" between coils, and other defects that are not visible to the eye but may cause sluggish operation or possibly complete failure of the motor.

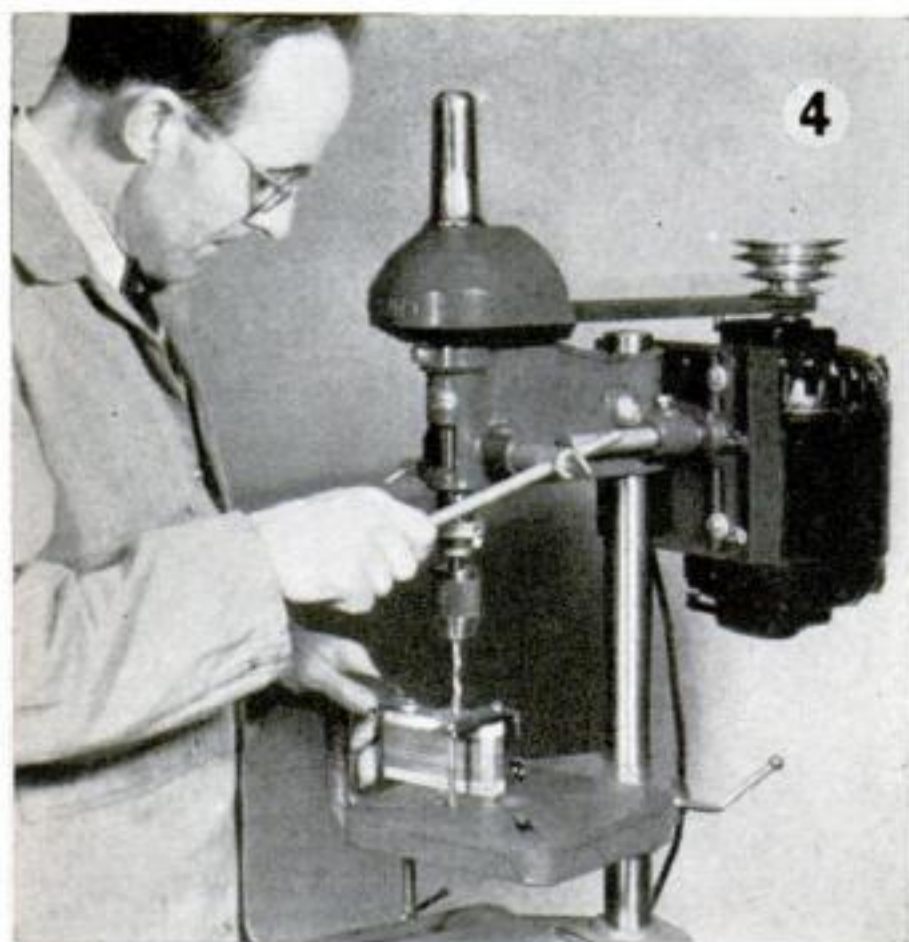
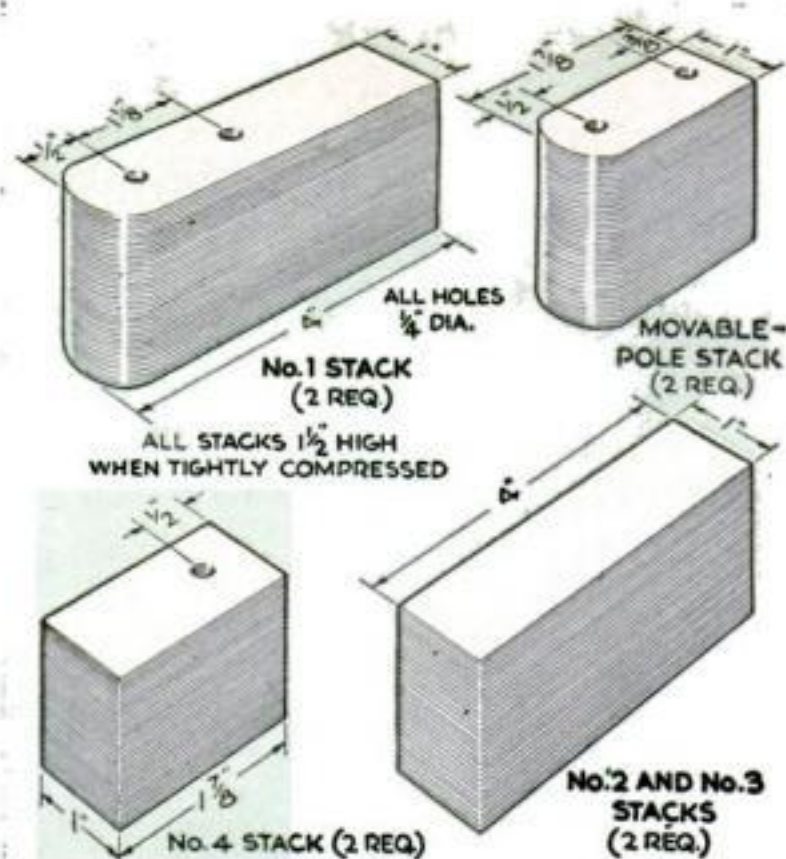
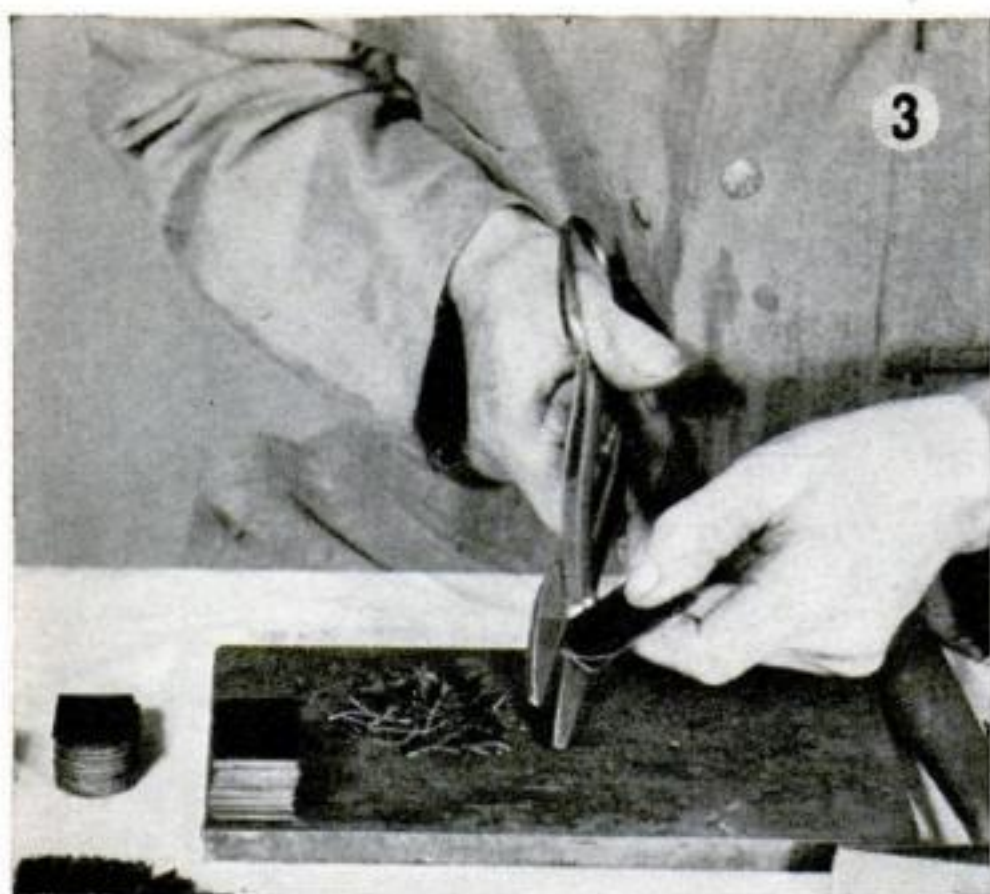
Any armature having commutator bars or segments separated by insulating strips, whether from a direct- or alternating-current motor, can be tested on a growler. It is necessary, of course, to remove the armature and place it on the growler, which, in principle, works much like an ordinary transformer.

The laminated core of the device is open



at the top, forming two poles. A 110-volt A.C. source is connected to the growler winding, and the armature to be checked is placed between the poles so that its iron core closes the magnetic circuit. Now the armature coils act as a secondary winding. A current is induced in them, but cannot flow unless a short circuit exists. If this is the case, an old hack-saw blade or other thin piece of steel will be attracted to the armature core where the defect occurs. If the armature is electrically in good condition, the blade will not be attracted. Fuller directions for the use of the growler will be given later on.

Besides being of the most efficient design, the shopmade growler illustrated has the great advantage of being adjustable. It will accommodate armatures from about $1\frac{1}{4}$ " to 5" in diameter (see Fig. 1 and Fig. 2). This is possible because the ends of the laminated poles are hinged in such a way that they can be moved to vary the gap between them. Because of its wide range, the growler should be found very useful in the electrical repair shop. Even the home mechanic who does not intend to rewind armatures himself will find it convenient for diagnosing motor troubles quickly. Its usefulness in the com-



Each stack may be clamped between two pieces of $\frac{3}{8}$ " thick hardwood, cut to the same size as the laminations. Tap the metal pieces to align their edges and secure them to the drill-press table. One of the side irons, two of the 4" stove bolts, and a C-clamp may be used for this, as shown in Fig. 4.

Check the stack carefully to see that it is precisely square with the table. Use a new drill, preferably one made of high-speed steel, at the lowest speed possible. Avoid forcing it, which may tear the sheet iron.

mercial garage is, of course, quite obvious.

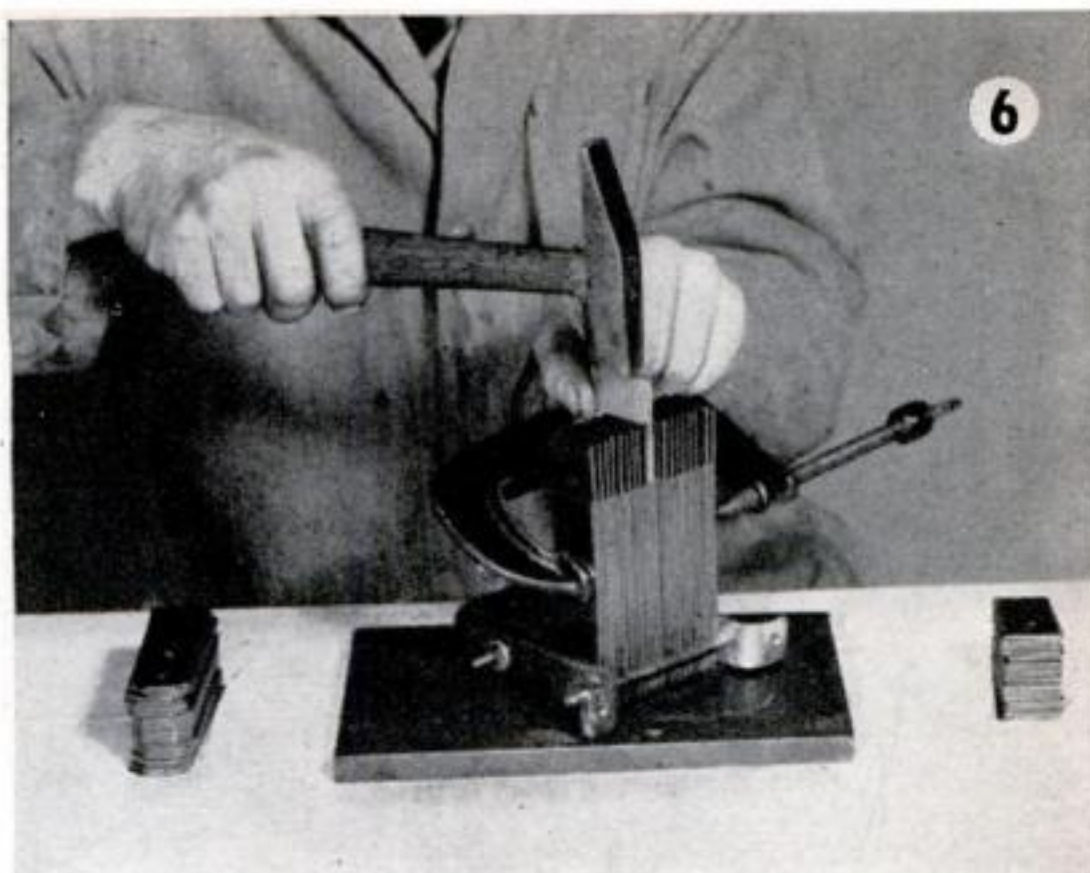
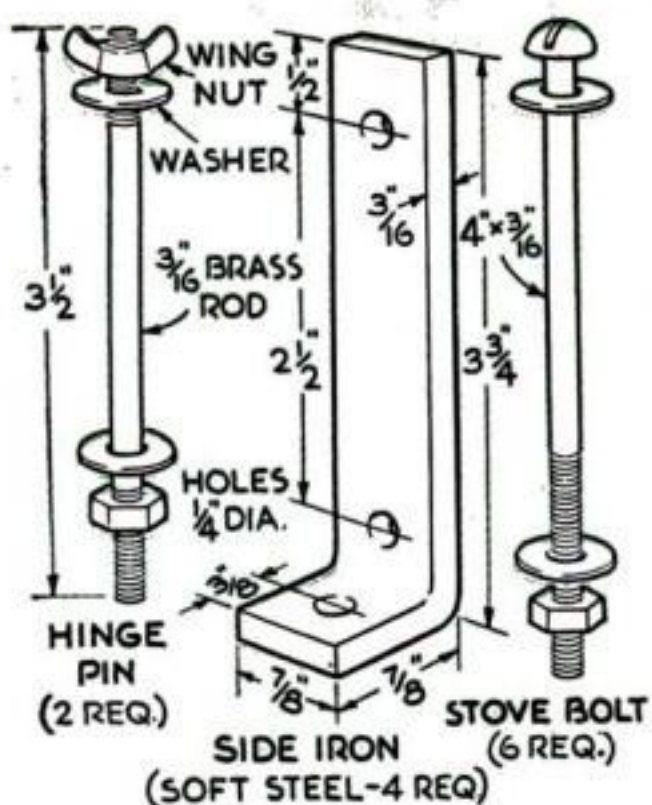
To make the core, have a tinsmith cut some 28-gauge black stovepipe iron into strips 1" wide with his foot-power shears. Machine cutting is necessary to insure straight and square edges. About 11 lb. of metal will be required. The strips should then be cut by machine into pieces of the size shown in the drawings. Four stacks of 4" pieces and four stacks of $1\frac{7}{8}$ " pieces are required, each stack being $1\frac{1}{2}$ " high when compressed tightly.

Using hand shears, round one end of each piece in two of the short and two of the long piles. One carefully shaped piece may be employed as a template for cutting the others (Fig. 3).

The holes must be accurately located and carefully drilled, as any inaccuracy here will cause difficulty in assembling the core.

LIST OF MATERIALS

- About 11 lb. of 28-gauge black stovepipe iron
- $3\frac{1}{2}$ lb. of No. 15 S. C. E. (single cotton, enamel) magnet wire
- 4 pc. $4\frac{3}{4}$ " by $\frac{7}{8}$ " by $\frac{3}{16}$ " soft steel or iron
- 6-4" by $\frac{3}{16}$ " roundhead stove bolts
- 2 pc. $3\frac{1}{2}$ by $\frac{3}{16}$ " brass rod
- About 90 iron washers, $\frac{3}{16}$ "
- 4-1" by $\frac{3}{16}$ " roundhead stove bolts
- 1 surface lamp receptacle
- 1 surface-type toggle switch
- 2 composition bushings, $\frac{3}{8}$ "
- 8' No. 18 two-wire rubber-type SJ (constant service) cord
- 6' No. 18 flexible insulated wire
- 10" No. 10 rubber-covered solid copper wire
- Miscellaneous: small pieces of $\frac{1}{2}$ " or $\frac{3}{8}$ " oak, maple, or plywood; attachment plug cap; varnished cloth; wing nuts and hexagon nuts; screws; paint; rubber tubing.



The location of the holes should be marked in advance on the upper wood piece, and the drilling should be continued into the lower piece.

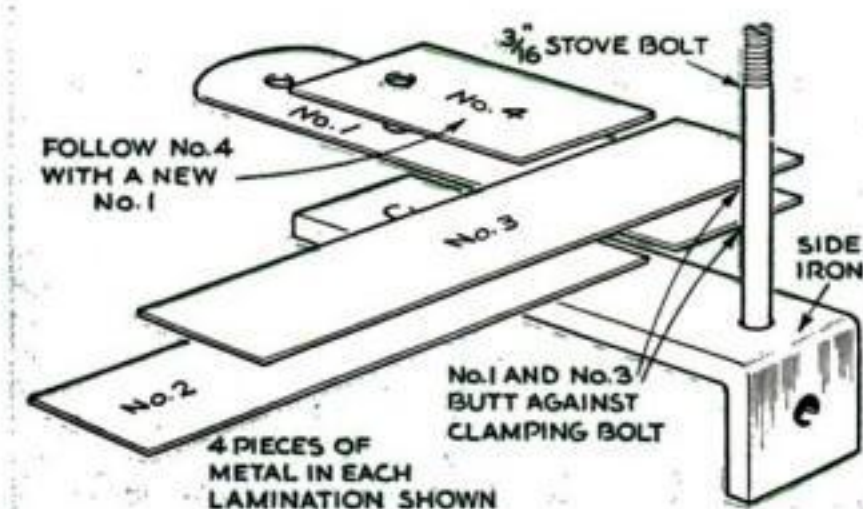
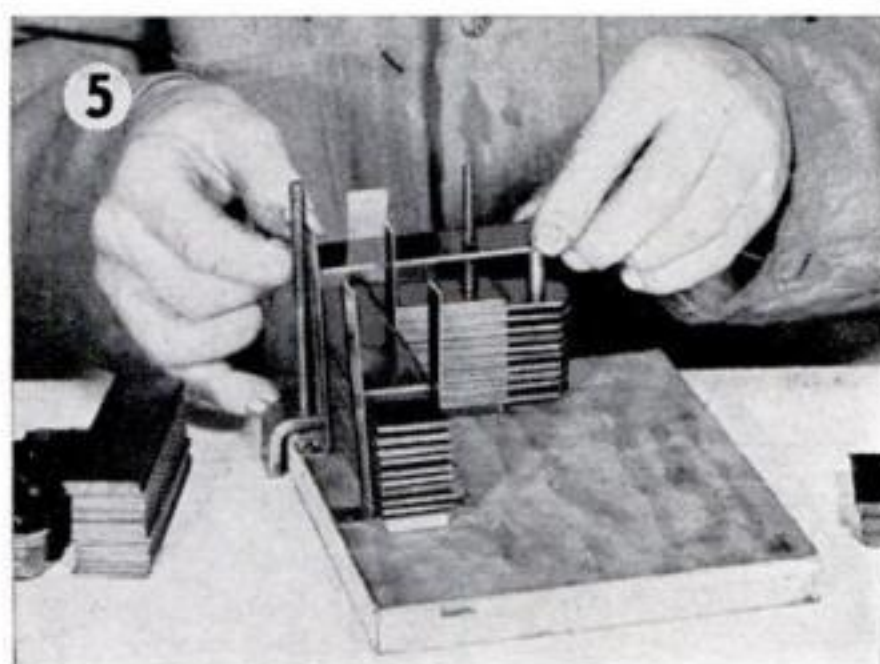
After the short pieces also have been drilled, inspect the laminations and file off any rough spots or burrs so that all the surfaces are perfectly flat. Prepare a stacking guide by laying one of the side irons, with two of the stove bolts pushed through the holes in it, on a small board so that the bolts stand upright. Holes drilled in the board for

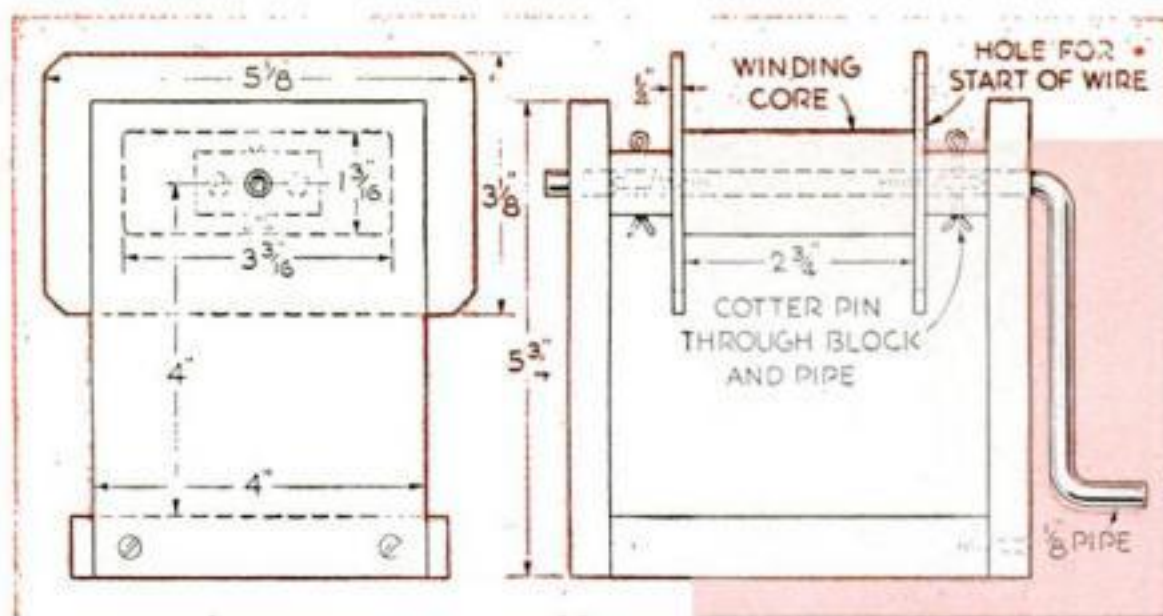
the boltheads will allow the side iron to lie flat. Tack several 1/2" wide sheet-metal strips in place to keep the stacked pieces aligned, as shown in Fig. 5.

Start with four of the 4" core pieces having rounded ends and two holes. Lay these pieces parallel to the side iron so that the upper bolt in the latter passes through them. Four of the undrilled long pieces are then laid at right angles to the first ones, forming a butt joint. A wood strip is placed underneath to hold these level with the others. Four identical long pieces are now laid to cover the butt joint between the first two groups, and four of the short pieces with square ends complete the first core layer. Continue stacking four pieces at a time in this way (Fig. 5), until the core is 3" high when tightly compressed; then place a second side iron on top and tighten nuts on the bolts to draw the assembly together firmly. A C-clamp may be used as an aid in making a tight stack.

Remove the clamped stack from the board and drive all joints tightly together with a hammer and a piece of 1/8" thick flat steel (Fig. 6). Use a try-square to check the angle formed by the two legs of the core; it should be exactly 90 deg. Wind a single layer of friction tape over the open leg (shown held with a C-clamp in Fig. 6), over which the coil will fit, and lay the core aside temporarily.

Dimensions for the winding core are given in the drawings, but they should be checked against those of the actual iron core. It will save time and insure better work to make the simple winding jig shown in the drawings and in Fig. 7. Apply four layers of varnished cloth over the wooden core, then wind with No. 15 S. C. E. (single cotton, enamel) magnet wire, of which 40 turns may be laid

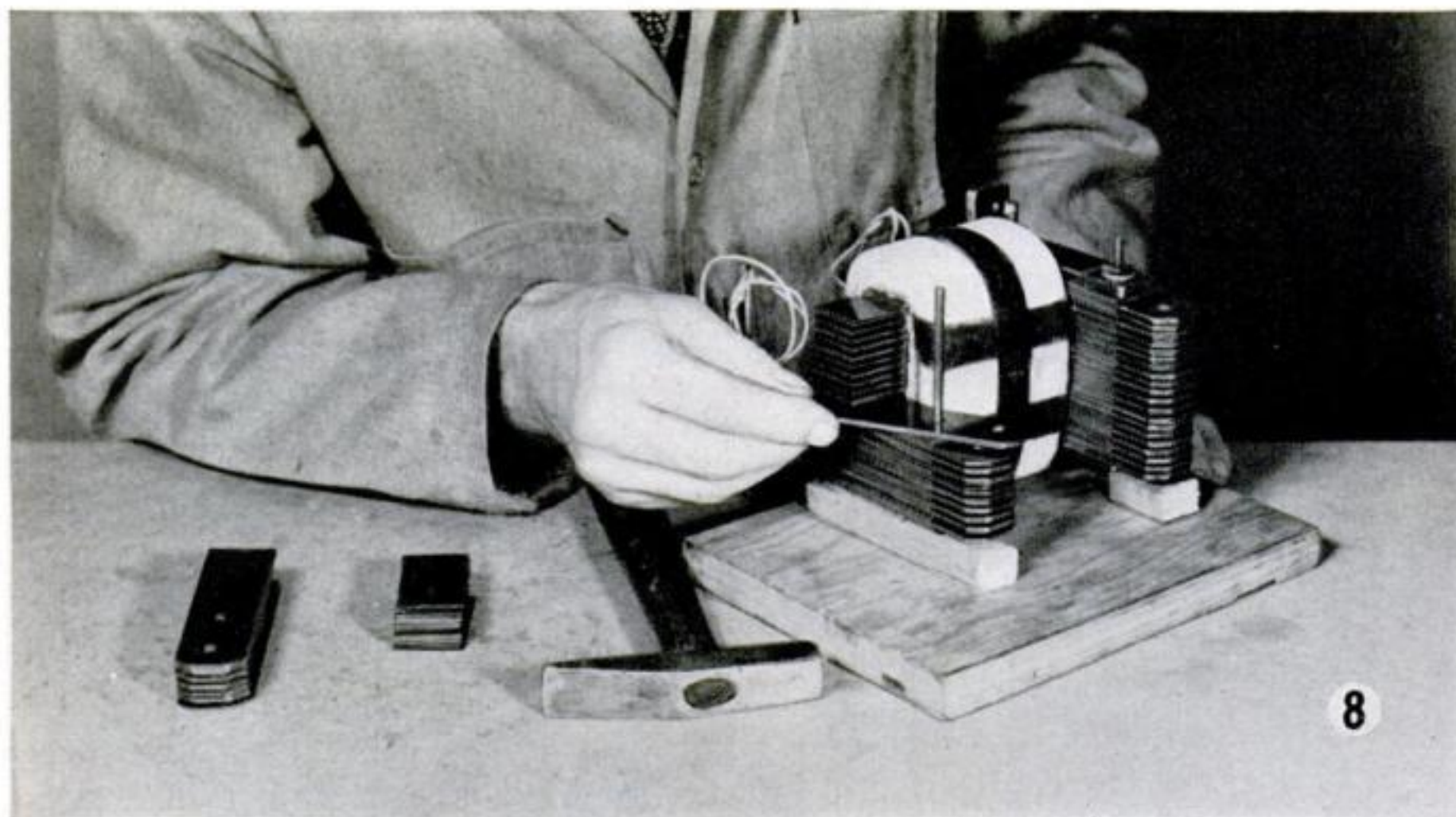
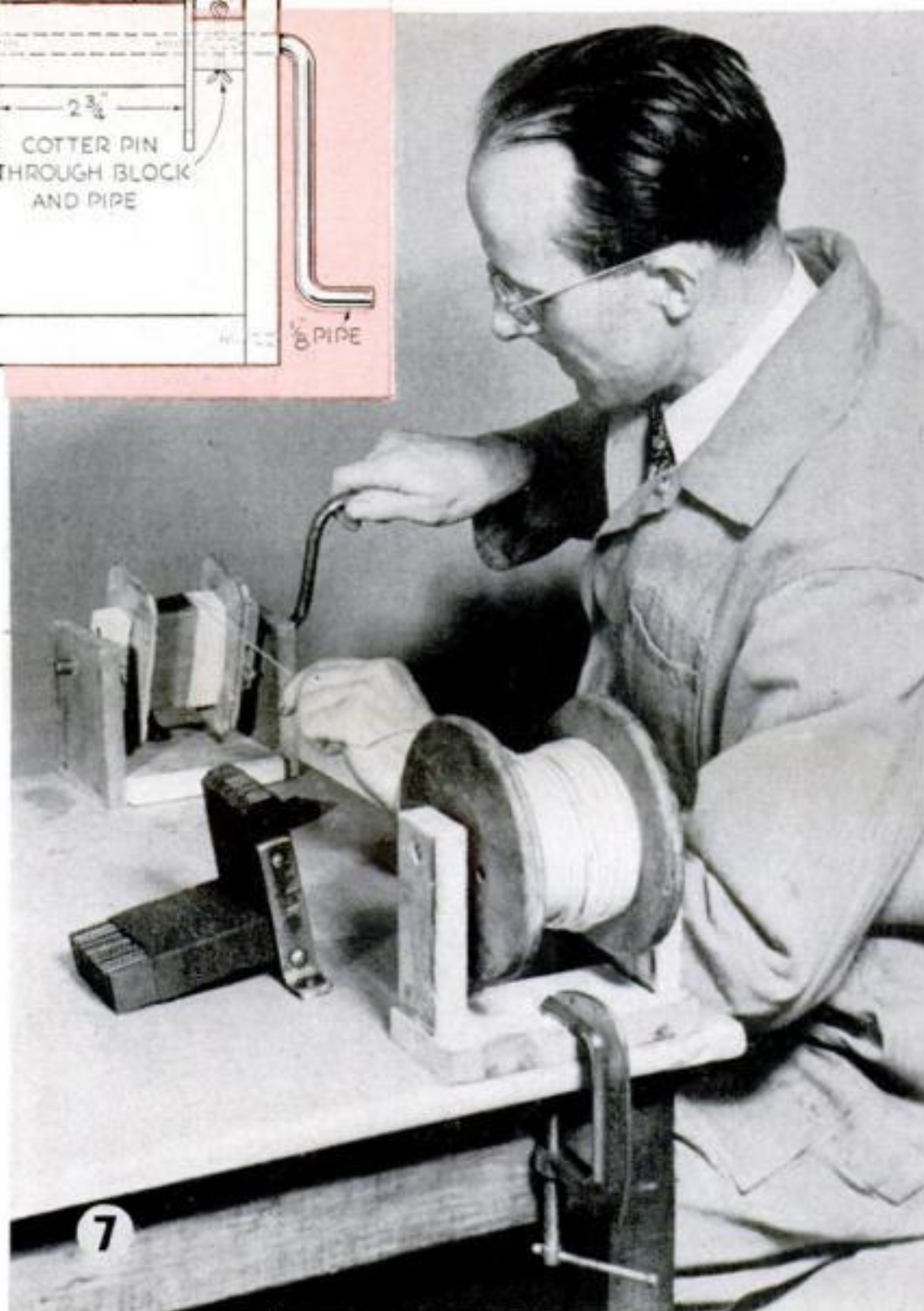




in the $2\frac{3}{4}$ " winding space. Eight layers, or a total of 320 turns, should be wound. Brown wrapping paper may be laid between the layers for additional insulation.

When completed, the coil is carefully removed and taped so that the windings cannot open (see Fig. 8), and put on the core, leads at the bottom. The other side laminations are then woven in as in Fig. 8, first four long pieces, then four short ones, and so on, to form a solid joint with the laminations first laid. The third side iron is used under this leg of the core, and the fourth finally laid on top of it. The clamping bolts are then tightened so that the assembly is firmly secured.

(TO BE CONCLUDED)





White partitions in an orange are made of cellulose. To prove it, steep some in an iodine solution and then drop sulphuric acid on them. They turn blue-black, indicating cellulose

Food Chemistry

SHOWN BY SIMPLE
KITCHEN-TABLE
EXPERIMENTS

WE MARVEL at the magic of modern chemistry, that changes wood pulp into artificial silk; coal tar into exquisite dyes; coal, air, and water into amazing fabrics and plastics. Yet, marvelous as these transformations may be, they are insignificant compared with the miracles that occur constantly in your own body. With all their skill, chemists still can't duplicate the complete process of digestion, assimilation, and transformation of food that occurs in the body. They have, however, learned a great deal about it. Many of their experiments may be duplicated with simple chemicals and equipment.

Food scientists classify food elements as carbohydrates, fats, proteins, and minerals. Carbohydrates serve primarily as fuel, releasing energy in the form of heat and in bodily power. Fats also provide fuel, and may be recreated in the body in the form of fatty tissue. Proteins are the substance from which the body repairs worn-out tissue and builds new. Minerals go to making bones and teeth, and also aid life processes.

Starch—a carbohydrate found abundantly in such foods as bread, grains, and po-

tatoes—is easy to detect. Put a little of the food to be tested in some water in a test tube, and cook for several minutes to break open the starch grains. After cooling, add a few drops of a dilute solution of tincture of iodine mixed with water. If starch is present, the solution will turn a deep blue-black.

Although starch probably constitutes the largest source of food, it cannot be used by the body until it is first changed into some form of sugar. Ordinarily, this change takes place in digestion. Sometimes it is wholly or partly effected by means of preparation or cooking. Cornstarch, for instance, may be changed into glucose, or grape sugar, by cooking with a dilute acid. Dextrin, which is an intermediate substance between starch and sugar, may be produced by baking starch in a dry heat. This is one reason why toast is more easily digested than untoasted bread. The starch in the surface layers has been changed largely into dextrin.

To prove this, break up a little fresh bread in water, shake it and filter. Test the liquid with iodine solution, and the blue-black starch reaction occurs. Now toast a

piece of bread and scrape off some of the very top golden-brown layer into a little water. Shake and filter, as before, and repeat the iodine test. If the starch had been changed completely to dextrin, the resulting color would be reddish. Because some starch still remains, the color will be purple.

Sugar, the other great form of carbohydrate, occurs chiefly in fruits, and in sugar cane and sugar beets. Common cane sugar must be changed into one of the less-known forms before it can be used by the body. Other sugars, such as malt sugar, grape sugar, milk sugar, fruit sugar, may be assimilated almost without change.

These sugars are known as reducing sugars, because of their ability to steal oxygen from certain chemical compounds. You may test for them by making use of this peculiarity. Your testing medium is Fehling's solution, made up of two solutions which you combine just before use. For the first solution dissolve 35 grams of copper sulphate in a little water, and then dilute with water to make a pint. Make the second solution by dissolving 173 grams of Rochelle salts in water, then adding 50 grams of sodium hydroxide. Cool this, and add water to make a total volume of a pint. To use, combine equal parts of these solutions and

add twice as much water as their total volume.

To find out if food contains reducing sugar, boil a sample of it for a few minutes in water, filter, and add the water to a little Fehling's solution which you boil for several minutes longer. Originally blue, the solution will turn yellow, or orange or brown, if reducing sugar is present, owing to the stealing of oxygen from the copper—changing cupric hydrate to cuprous hydrate, which is precipitated.

When Mother makes jams and preserves, combining sugar with acid fruits, an interesting reaction occurs which may be proved by the same test. During the process of cooking the fruit with the sugar, part of the cane sugar remains as cane sugar and part is changed into "invert" sugar, a combination of grape and fruit sugars. It is to produce this reaction that lemon juice or tartaric acid is often added to jams made of material containing little acid. By mixing a little jam with water, and testing as before, the invert sugar may be discovered.

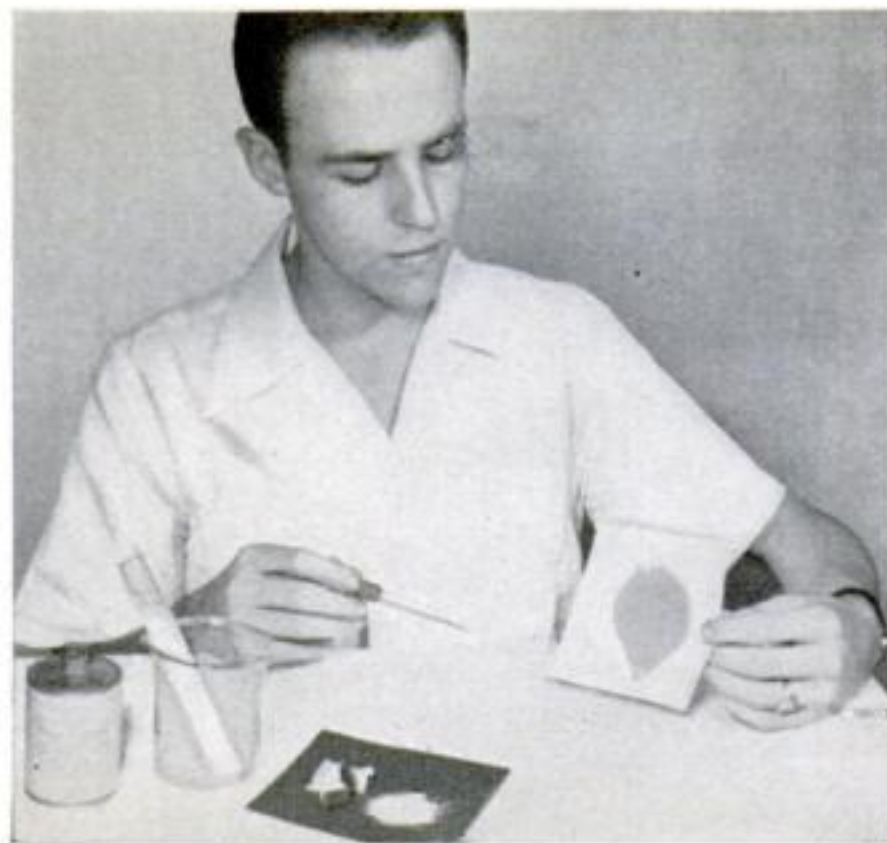
Cellulose, which makes up the cell walls and fibrous portions of plants, is a carbohydrate which helps clean out the body by providing roughage, but which cannot be digested by man



A test with Fehling's solution shows that some of the cane sugar in jam has been changed into "invert sugar"



To show how ptyalin in saliva changes starch into malt sugar, samples of starch-and-saliva mixture taken at 20-second intervals are applied to successive drops of iodine test solution on a plate



The grease-spot test for fats. Shake a little of the food to be tested with ether and put a few drops of the solution on glazed paper. If fat was present, a grease spot will be left on the paper

and converted into fuel. Strangely enough, its chemical formula is exactly the same as that of starch. To test for it, cut out the white partitions in an orange or lemon and scrape them clean of pulp. Steep the partitions in an iodine solution, and then drop strong sulphuric acid on them. The resulting purple-blue color indicates cellulose.

Fats in foods may be easily detected by means of the familiar grease-spot test. Shake a little of the food—mashed up, if it is a solid—in a few cubic centimeters of ether, which readily dissolves fats. Pour some of the ether on a sheet of thin paper. If fat is present, a grease spot remains after evaporation.

Without proteins we should soon die, as neither fats nor carbohydrates contain nitrogen, which is an essential element in body construction. That protein contains nitrogen may be quickly determined. Heat some dry soda lime in a test tube with a substance containing protein, such as chopped boiled white of egg. Ammonia gas—which is a combination of nitrogen and hydrogen—will be given off. Food may be tested for protein by heating a little of it with strong nitric acid. If protein is present, the food turns yellow.

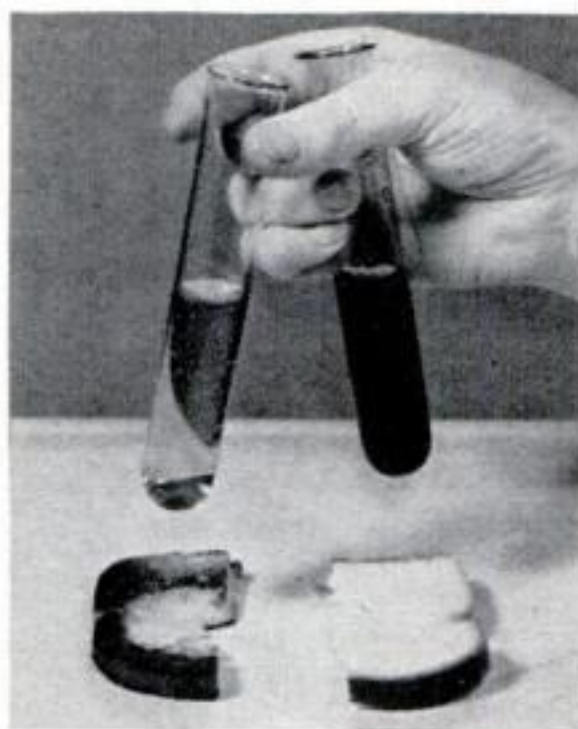
Digestion itself may be demonstrated vividly with the aid of only a little starch, saliva, and the iodine test. Think of a nice juicy lemon, and transfer the saliva that collects in your mouth to a test tube, until the tube is a quarter full. Then add as much water, and stand the tube in a water bath heated to about 38 degrees C. Mix a few grains of corn starch with half a test tube of boiling water, and boil about five minutes. Cool, and place also in water bath. On a plate, place a number of separate drops of iodine solution.

When both saliva and starch are at temperature of water bath, put about 20 drops of saliva into the tube containing starch. Immediately take out a drop of the mixture



Protein contains nitrogen. To prove it, heat some dry soda lime in a test tube with chopped boiled white of egg. Ammonia gas, which is a combination of nitrogen and hydrogen, will be given off at once

Tests show that some starch in toasted bread has been changed to dextrin, while fresh bread gives the pure starch reaction



Salts of heavy metals precipitate proteins from solution, explaining why white of egg is an antidote for metal-salt poisons

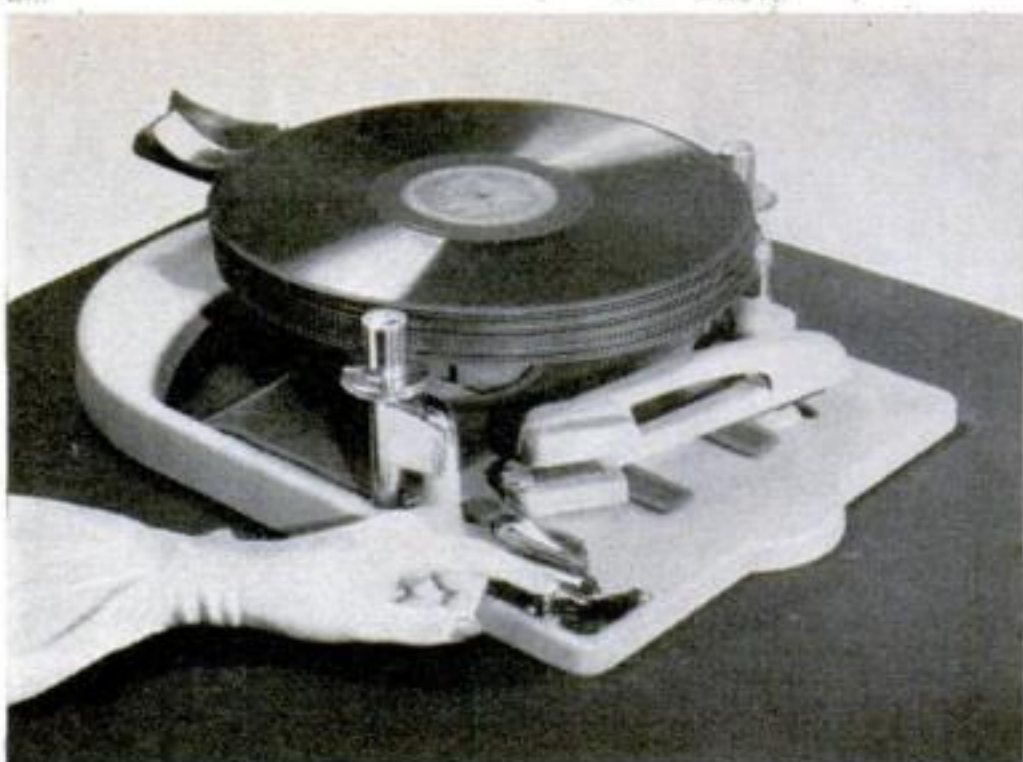


and add to one of the iodine drops. Deep blue, indicating starch, appears. Now dip out drops about every 20 seconds, adding them to successive drops of iodine. Each drop gives a reaction of different color—ranging from blue-black through purple, mahogany, red, to no color at all.

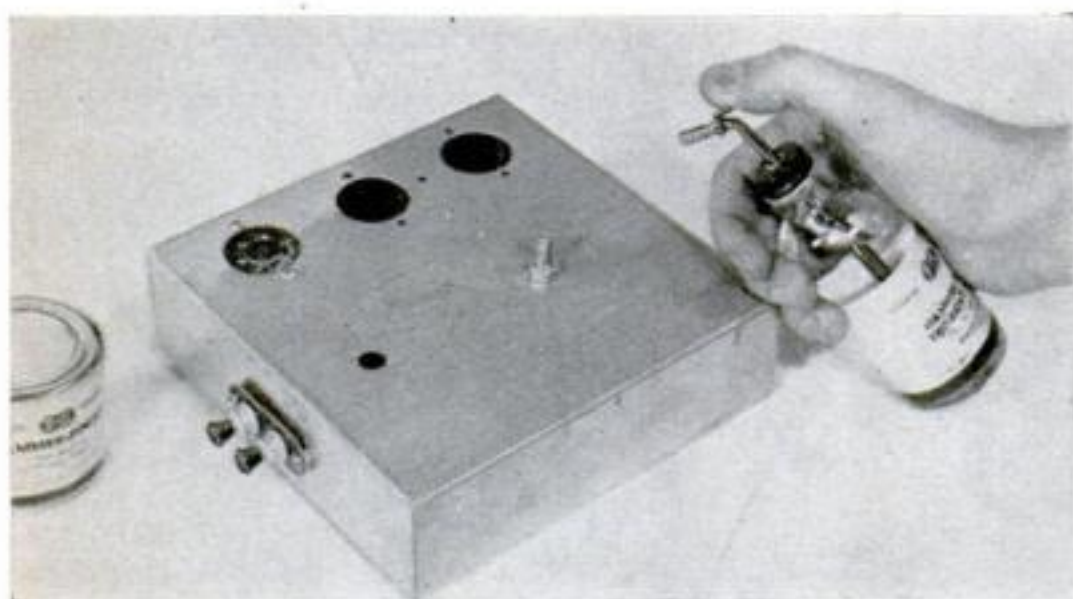
The reason? The enzyme ptyalin, in the saliva, initiates the process of starch digestion. Beginning as pure starch, the substance gradually changes to dextrin, and then finally to maltose. The latter may be detected with Fehling's solution.

Radio Ideas

A TANDEM PICK-UP ARM, which plays both sides of a phonograph record without turning it over, is the feature of a new automatic record changer. After the starting button is pressed, the new instrument will provide as much as two hours of uninterrupted music. Formed of one arm and two pick-ups, the device plays first the top side, then the bottom side, of each record in turn. After reaching the end of the upper side of the record, the arm swings clear of the disk while the direction of the turntable is reversed. Rising, it then makes contact with the under side of the record. When both sides have been played, the arm again

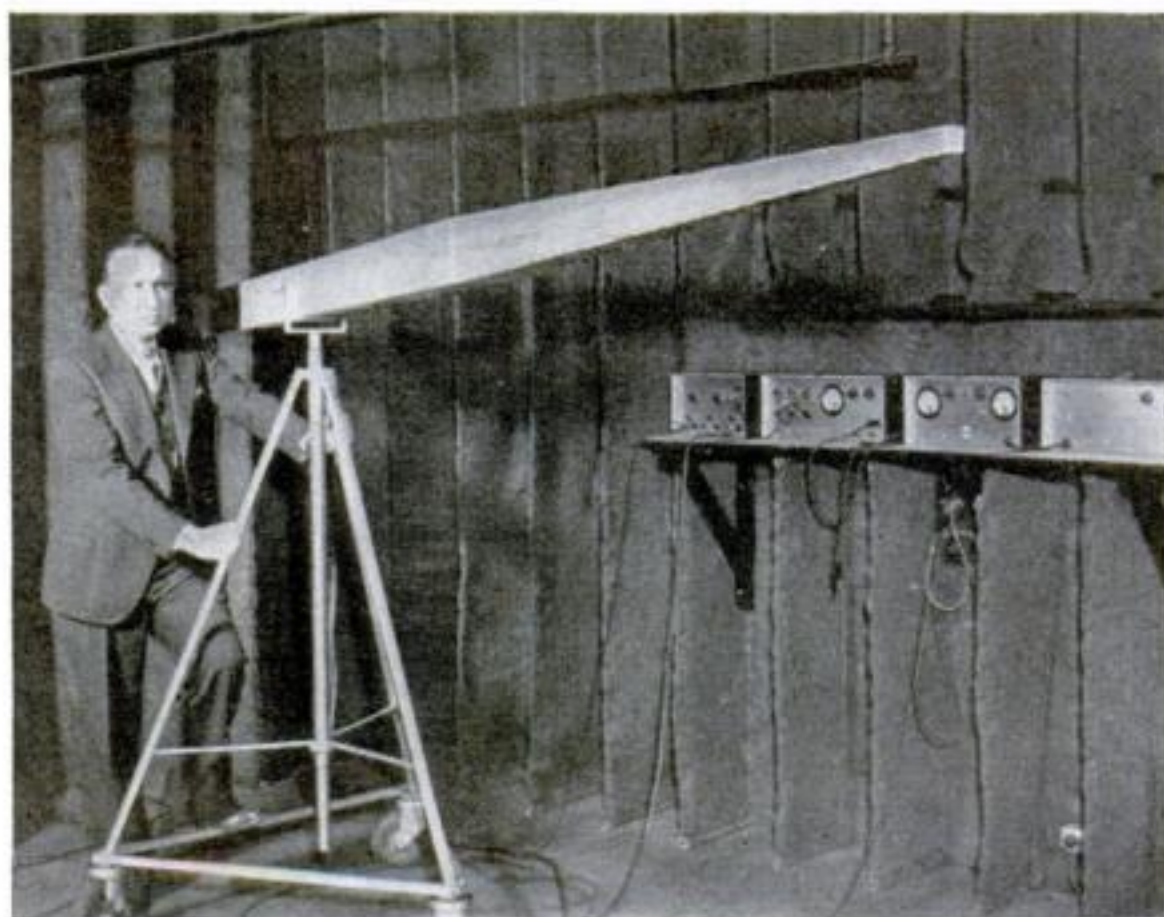


swings away while the disk descends into a felt-lined compartment below. Another record, from the bottom of the pile above the arm, drops into place and the procedure is repeated. A record may be rejected while playing by pushing the starting button.



A HAMMER-METAL EFFECT, such as is found on many of the latest amplifiers, microphones, and radio panels, can now be produced at home by means of a simple two-coat process. The base coat is applied with a paint brush, providing a smooth foundation. Over this, the second coat is sprayed on with a hand applicator to produce the hammer-metal finish. The finish, which dries rapidly with baking, is available in seven different colors.

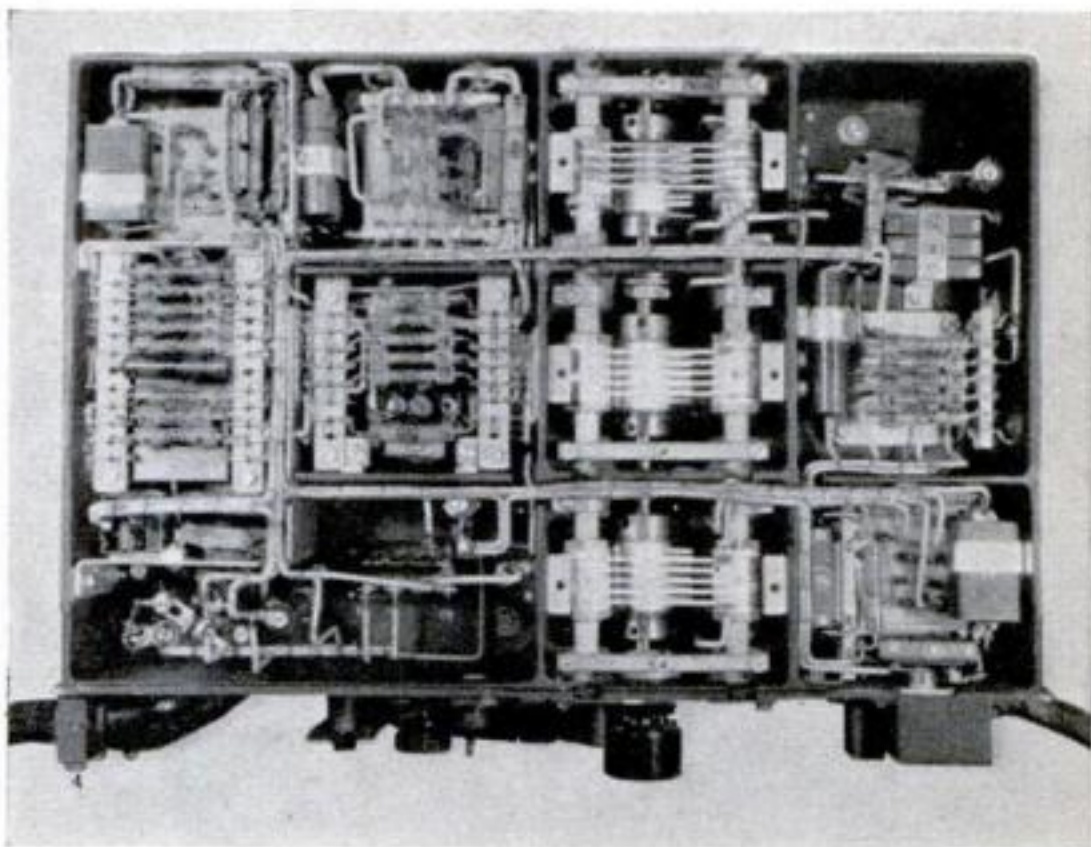
LONG-DISTANCE RECORDING for radio, television, and movies is made possible by a new "line microphone." Appearing at first glance like a telescope mounted on a wheeled tripod, it is ten feet long and consists of a series of quarter-inch pipes encased in a perforated metal sleeve. The perforations are pick-up points for sound waves, which are carried through the pipes to a ribbon transducer where they are changed into electrical impulses. Unlike the conventional microphone, it is highly directional, and can pick up such sounds as the music of an orchestra at a distance of 100 feet.





HOUSE CURRENT, either A.C. or D.C., can be used to operate a new camera-style personal radio. Including the rectifier, the little set is equipped with five tubes. It has a power-control switch on the dial panel and there is provision for the attachment of a separate window antenna for increasing the sensitivity of the set. The power-line cable for connecting to the house current plugs into the back of the radio case. If desired, the outfit can be operated on dry cells instead of house current. Finished in gray plastic, the camera-style set has a dark-blue covering of simulated leather.

MESSERSCHMITT RADIO EQUIPMENT, obtained from a Nazi fighter plane shot down in England, has been examined carefully by American engineers. They have found the receiver, shown at right, lacking in many of the improvements standard on American equipment. In forming the tube sockets, terminal boards, and coil forms of the set, the German designers used ceramics instead of plastics. The various leads used in the wiring were covered with varnished cambric tubing. When special sub-assemblies were fastened by means of screws, the screws were locked in place by means of cement instead of lock washers.



CORNER-POST ANTENNAS for automobiles have been designed as an aid to safer driving. By attaching the antenna at the corner of the car, the possibility of interfering with the sight of the driver is eliminated. The new-type antennas are curved to conform to modern streamlined design and are heavily chrome-plated. Supplied with each antenna is a weatherproofed shielded lead-in cable and a bayonet adapter for plugging into the antenna post on the car's radio.

MIDGET TUBES recently developed primarily for use on the ultra-high-frequency bands also work satisfactorily on the broadcast band, making possible compact three and four-tube receivers. They have an overall height of $1\frac{3}{4}$ inches and a diameter of only $\frac{3}{4}$ inches. The tubes are of all-glass construction, with a seven-prong glass button base. Heater voltage rating is 6.3 volts A.C. or D.C. at .15 amperes.

You Can Build— **FM RECEIVER FOR \$22**

By **ARTHUR C. MILLER**

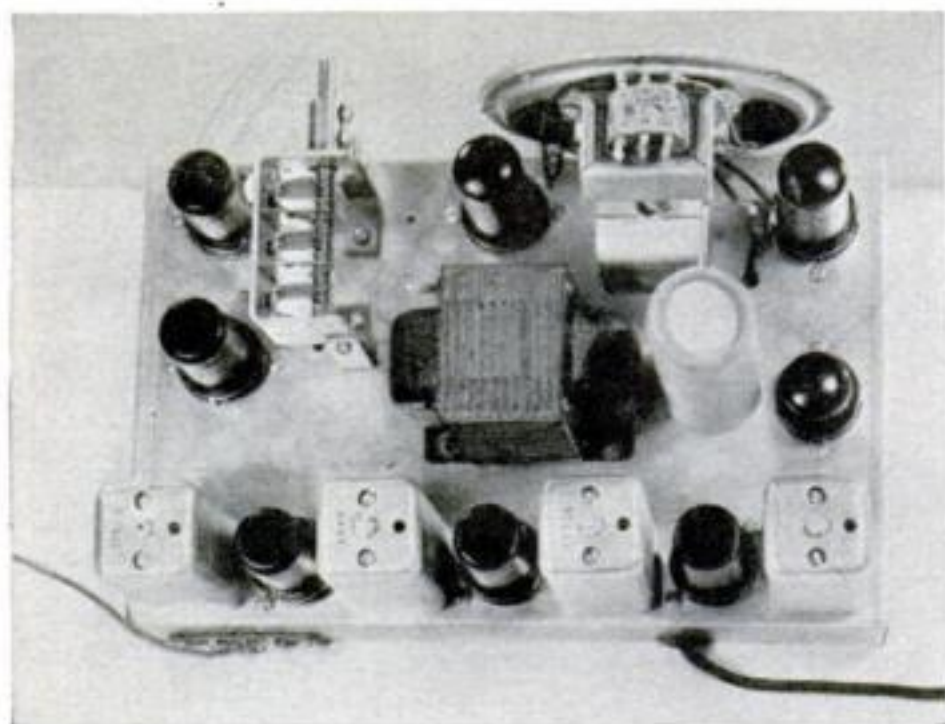
THIS unit is not just another FM converter, but a complete eight-tube FM receiver, and it can be built for only \$22. Extremely compact, it is mounted in a cabinet usually sold for four-tube receivers.

A simplified version of the original FM circuit is used, a circuit so rapidly becoming standard that a kit of low-cost components has been put on the market. These parts, used in this design, are a set of three FM coils (antenna, RF, and oscillator), three special FM I.F. transformers peaked at 4,300 kilocycles, a discriminator transformer, also peaked at 4,300 kilocycles, and a three-gang tuning condenser, each section having a capacity of 7-22 mmfd.

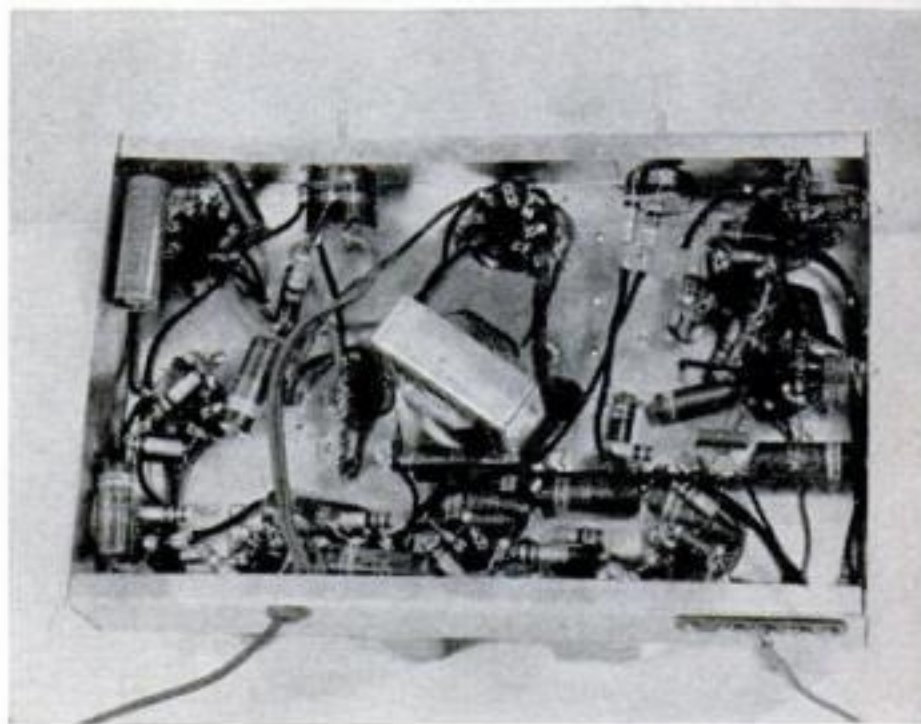
The main difference between a standard broadcast superhet and an FM superhet is the use of a limiter tube and a "discriminator" stage. Otherwise this FM receiver consists of the usual R.F. stage (converter stage) and two I.F. stages (second detector and audio stage). The "discriminator" stage makes possible the detection of FM impulses and discriminates against standard or amplitude-modulated impulses.

In an FM receiver all grid and plate leads must be as short as possible, especially in the RF and converter stages. The layout here allows short leads between the tube prongs, condensers, coils, etc. The 10,000-ohm, 1-watt loading resistors across the secondary windings of the coils stabilize and balance the I.F. circuits. An elaborate decoupling system in each plate and screen lead of the first five tubes eliminates feedback between the circuits which would cause oscillation. The rectifier tube and circuit deliver 250 volts at about 60 milliamperes.

Front panel of the FM receiver described in this article



Top view of chassis, showing the compact layout of tubes, transformers, condensers, and speaker, which permits installation in a small, four-tube cabinet



Bottom of chassis. Note filter choke in center and the special FM coils on extreme right. A phone jack indicated in diagram is not shown

It is difficult to align an FM receiver, and a dependable dealer will do it for you. Those who are ambitious, however, and can obtain a signal generator can do it at home. Align the discriminator transformer by applying a signal of 4,300 kilocycles to the grid of the 6SJ7 and connecting an O-1 ma. meter with a 100,000-ohm resistor in series with the meter across the 6H6 cathode. Adjust the secondary trimmer of the discriminator until a movement of the meter's needle is noted. As the trimmer is tuned, the meter will go plus or minus, either side of the resonant frequency. Set the trimmer so the meter reads zero voltage. The primary trimmer of the discriminator transformer is adjusted to the maximum reading when it is connected between the center tap of the transformer and ground.

To align the I.F.'s the same O-1 ma. is connected in series with the grounded side of the 50,000-ohm variable resistor (sensitivity control). By-pass the meter with a .02-mfd condenser, and apply a 4,300-kilocycle signal to the grid of the preceding 6SK7. Tune the transformer for a maximum reading on the meter. Apply a signal to the next 6SK7 and repeat the procedure. To align the trimmer condensers on the three-gang tuning condenser, tune in a station and adjust each trimmer, by ear, until the station is received at maximum volume.

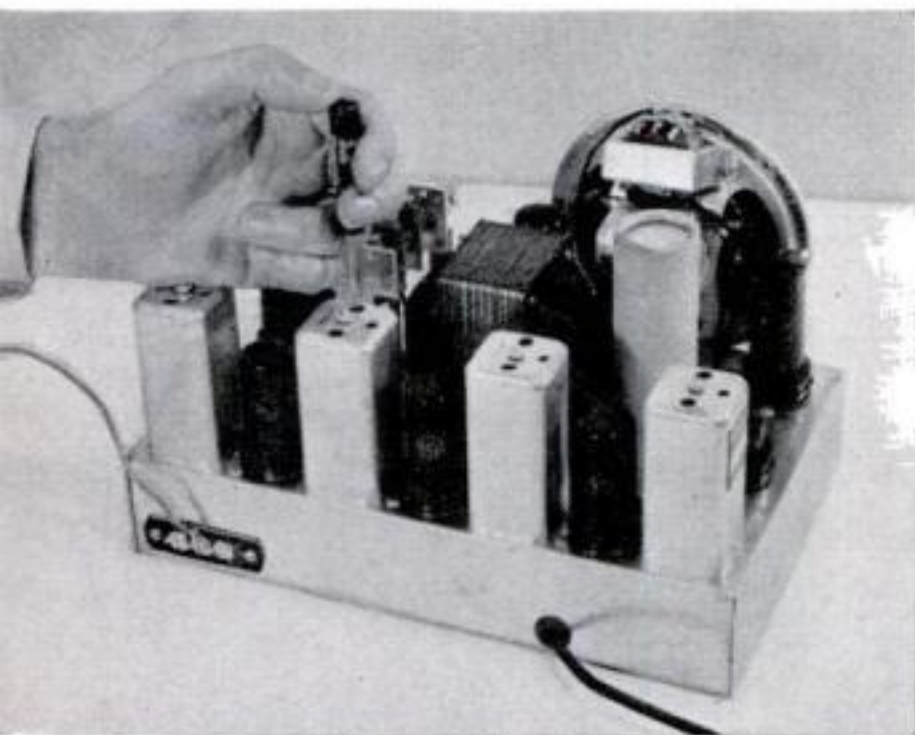


Adjusting the trimmer condensers. The steel cabinet has a hinged lid

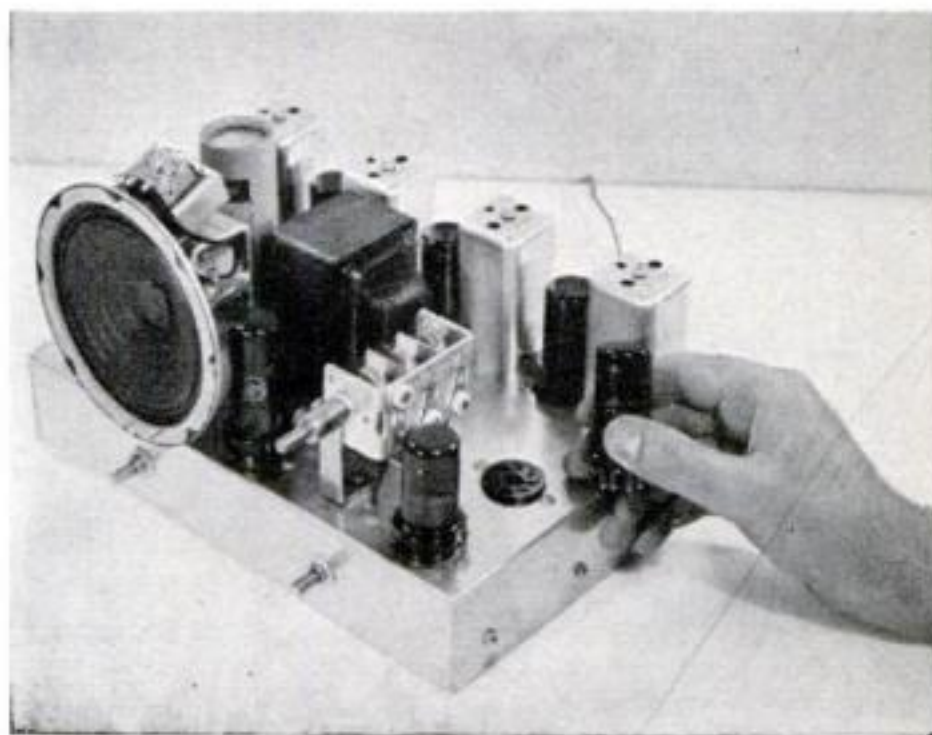
If the set is located within ten to 15 miles of an FM broadcasting station, a short piece of wire (about ten feet) connected to point "b" on the antenna binding post will suffice, but for best results a special doublet FM antenna should be connected to "a" and "c" on the binding post.

There are two important points about FM reception to keep in mind. First, the discriminator stage will not operate satisfactorily unless a sufficiently strong signal reaches the grid of the 6SJ7. Secondly, the range of FM is limited to about 50 miles.

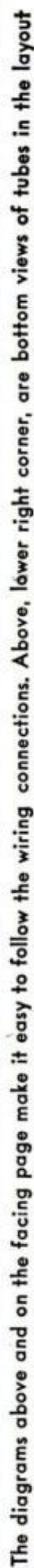
The five-inch permanent magnet speaker does not do justice to high-fidelity FM reception. It is better to buy one of the high-fidelity speakers now sold for FM reception and use the small speaker just for speech or for monitoring the reception.

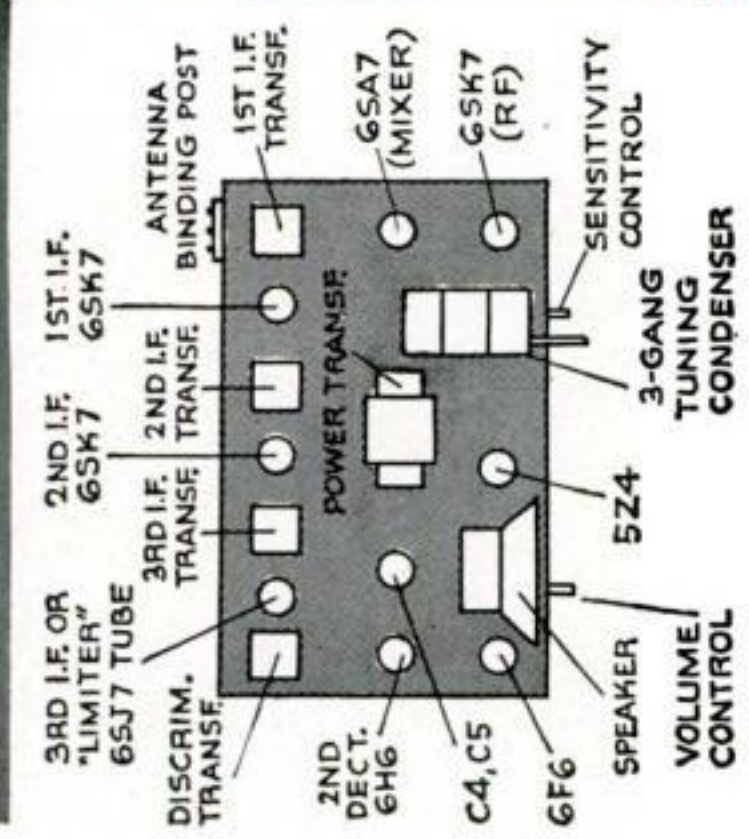


Making final adjustments. Since the tubes and power transformer generate heat, two four-inch ventilation holes should be cut in cabinet's back



View of the RF portion of the FM chassis, showing the three-gang tuning condenser, the 6SK7 RF tube at front, and the 6SA7 mixer tube held in the hand





mfd., C26 to C28; .004, C29.
Carbon resistors: (4) 1,500
ohms, 1 watt, R1 to R4; (5)
50,000, 1, R5 to R9; (3) 10,-
000, 1, R10 to R12; (5) 100,-
000, 1, R13 to R17; (3) 150,
1, R18 to R20; 250,000, 1,
R21; 400, 2, R22; 75,000, 1,
R23; (2) 20,000, 1, R24-R25.
**FM coils; antenna; RF; os-
cillator.**

Transformers: output; power, 680CT-70, 5 volts-2 amp. 6.3-2.5 amp.; discriminator, 4,300 kc.; (3) FM I.F., 4,300 kc.

Filter choke, 11 henrys, 300 ohms.

Variable resistors (2); 50,000 ohms; with switch, 500,000.

Speaker; octal sockets; steel chassis; cabinet; tubes etc.



Good Portraits Must Be Planned

"There's no such thing as a lucky shot," says Pirie MacDonald in an interview with Popular Science

PIRIE MACDONALD, world-famous portrait photographer, has given most of his life to the art of making human portraits of human beings.

He is devoted to that art. He values it and respects it. He takes an artist's and a craftsman's pride in his work, and a deep satisfaction in the results of that work. And if there is one word he hates and despises in connection with his work, that word is "luck."

MacDonald says simply that luck has nothing whatever to do with the making of a really fine portrait. To make one you must know what you want to do, and know how to do it; then you go ahead and do it. The element of luck or chance doesn't come into the process at all.

Pirie MacDonald is in his seventy-fifth year now, and 58 of those years have been dedicated solely to the professional practice of photography. He is a tall, spare, tempestuous man, with a sizable streak of Scottish reserve until he gets excited about something.

Then he will stride around his studio on New York's Fifth Avenue, his cheeks growing pinker and pinker, his crisp, iron-gray hair seeming to bristle—even the ends of his neatly trimmed mustache appear to point due north a bit more sharply. And as good a way as any to get him excited is to raise the subject of luck in portrait photography.

"When you talk about photographic portraits—really good ones—there is no such thing as a 'lucky shot.' That phrase is anathema to me," he will tell you. "The man who talks about a lucky shot in making portraits is simply offering his confession that he didn't expect to make a good picture when he started. He is trusting that some accident of good fortune will make up for his own lack of serious purpose and workmanlike intention. There is no luck in a good portrait at all. A good portrait is pre-

Pirie MacDonald, a self-portrait, at left. For four decades he has concentrated on the portrait photography of men, and his work has acquired an international reputation. To put aside the temptation to glamorize, he resolved never to photograph a woman again. He has stuck doggedly to that determination



MacDonald's portrait of the poet, John Masefield

conceived; it is premeditated; it is planned."

MacDonald's reputation as a portraitist is national and even international. His work has been so widely exhibited and even more widely reproduced that many of his pictures are familiar to those who know little of the art of photography. Professional photographers and laymen alike look upon him as a man who has attained an ambition while concentrating for four decades on his chosen field—the portrait photography of men subjects. For years his advertisements have identified him: "Pirie MacDonald, Photographer of Men."

His early career, however, is not so well known. One fact that invariably amazes MacDonald's friends is that he left school at the age of 11 years, and has never had any formal education since then. Constant reading and study, plus a passion for travel, have given him a broad cultural background. Word roots are a special enthusiasm which he gratifies; for many years he has never gone to bed without a dictionary on the night table at his side. (Continued)

His first job was that of handy boy in an iron foundry in Troy, N. Y. While still in his early teens, he became interested in the then young profession of photography, and when he was 17 years old he got his big chance to start work as apprentice in the local photographer's studio. His pay was only \$4 a week, and his apprenticeship lasted for seven years. By then he felt that he knew his craft. Furthermore, through economies remarkable even for a lad of Scottish extraction, he had accumulated \$75 with which he contrived to open his own studio in nearby Albany.

Photographers were still using wet plates when he broke in—they were mixing their chemicals and sensitizing their plates just before they were to be exposed. MacDonald recalls his first and only master as a regular giant of a man (he was descended from an old whaling family in Stonington, Conn.), a man of vast dignity and inflexible standards.

"He was a man of principle," MacDonald muses, "but like so many of the pioneers, he was devoted solely to the idea of making perfect technical records, and gave no thought to the element of human character

in photography. I think the event that really started me on my own path occurred one day when a farm woman came into our shop with some proofs of pictures we had made of her husband.

"She wasn't satisfied, and when she tried to explain why, all she could say was, 'He doesn't look out of the pictures the way he looks at me.' After our chief heard about it, he took the proofs, peered at them intently, and finally said, 'They're all perfectly sharp; he didn't move.' And that was all! One of his assistants made some more pictures at a later sitting and the woman finally got something that appeared to satisfy her.

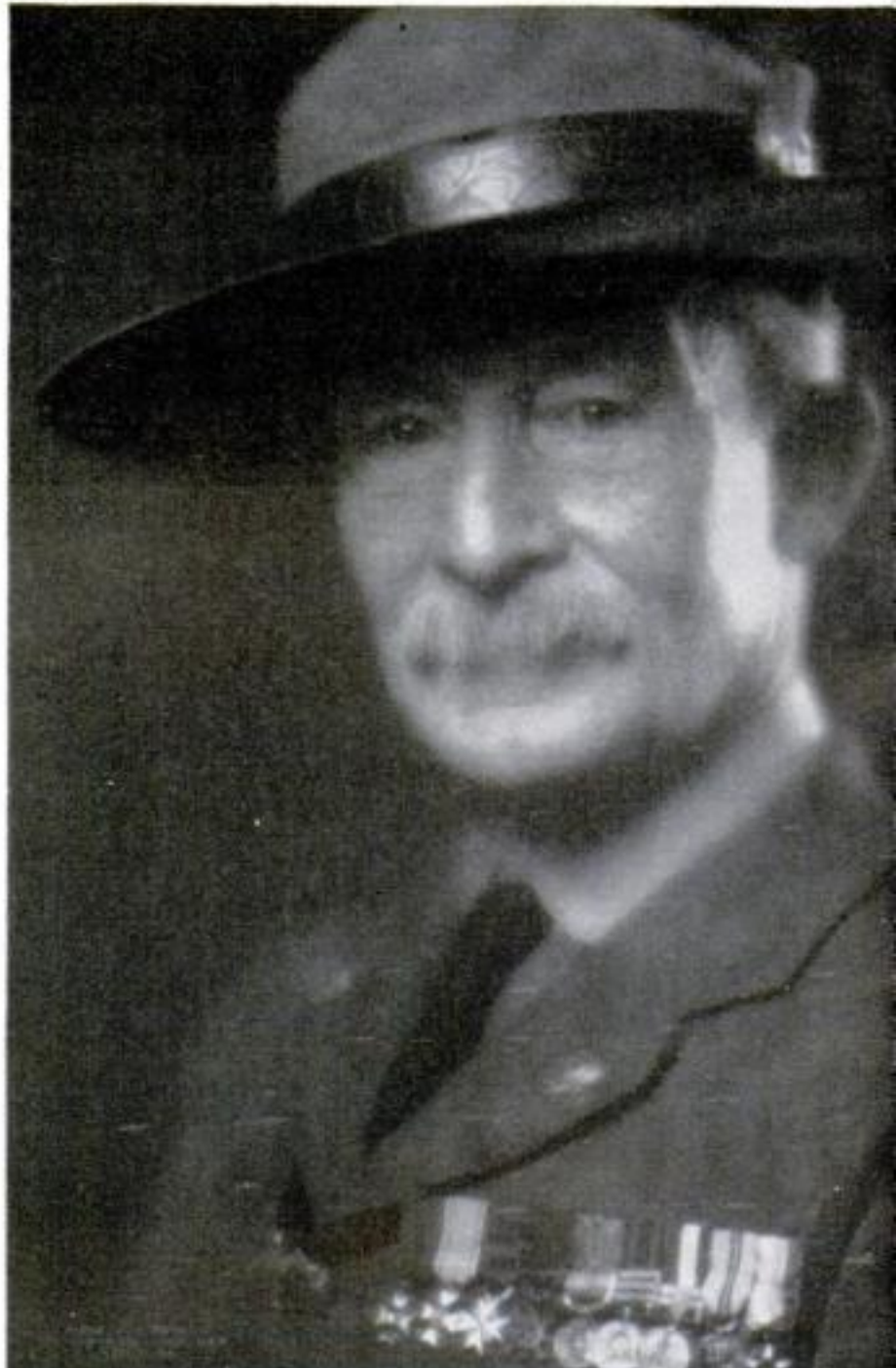
"But I couldn't forget what she said: 'John doesn't look out of the pictures the way he looks at me.' That set me on the right track. It's not an easy thing to explain, but I believe that to make a true portrait you must try to analyze and understand your subject's character, and deliberately aim to reflect that character in the picture. The essence of the whole process is the human being you are trying to portray."

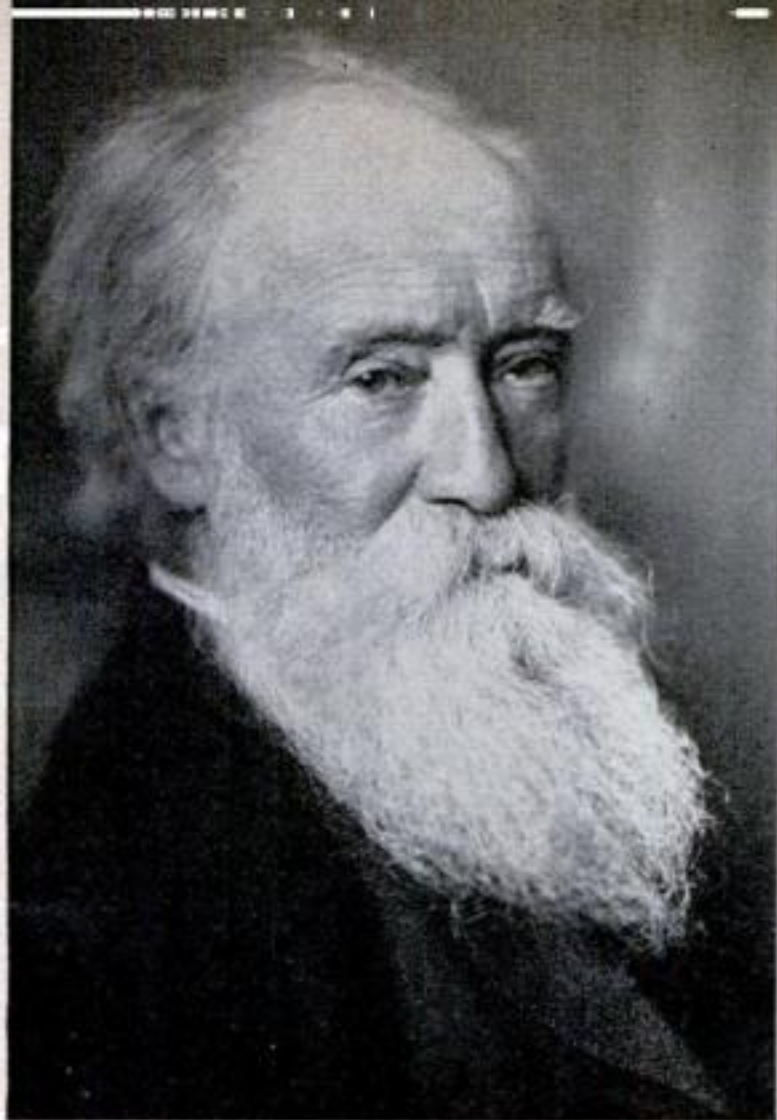
In thus stressing character study, Mac-

Theodore Roosevelt—his wife's favorite photograph



Lord Robert Baden-Powell, Boy Scouts founder





Pirie MacDonald's study of the famous American naturalist, John Burroughs



Portrait of Arnold Bennett, who wrote many great novels

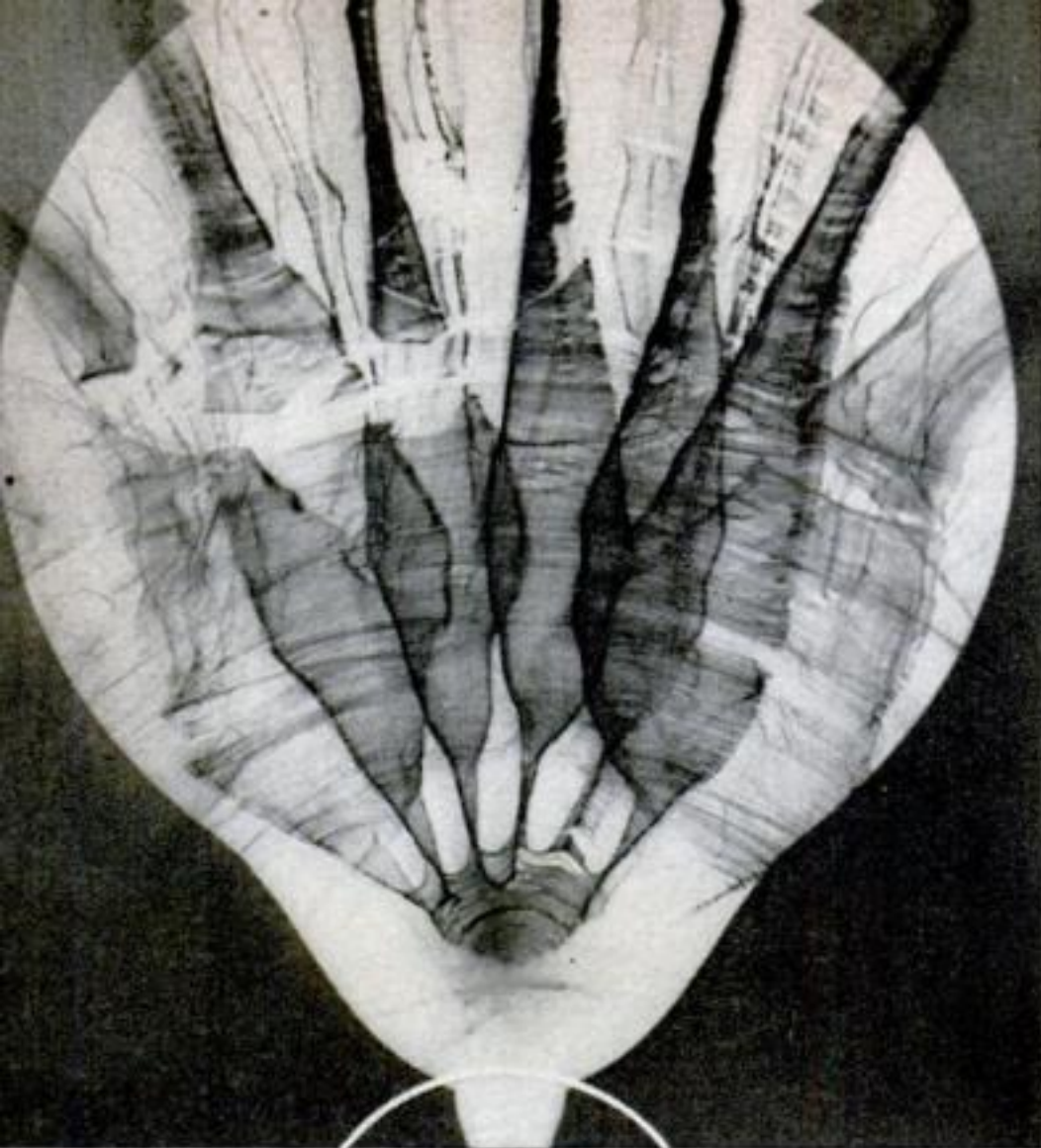
Donald does not imply or excuse any neglect of photographic technique, which he regards as basic and essential—the learned method which enables you to carry out your plan. On the subject of techniques, however, he refuses to be dogmatic. Technique is individual rather than general, he explains, and each man must learn and develop his own by experience.

On the question of lighting, for example, MacDonald will tell you that the human head has a definite structure, and the modeling of that structure in a photograph is a very precise and subtle problem. Each photographer must work out that problem for each subject; but for himself, MacDonald is convinced that the construction of the head does not permit effective use of light from below. Back lighting has some uses, he thinks, but it can be greatly overdone, and the kind of back lighting that puts a halo or aura around the head is sentimental, untrue, and absurd.

MacDonald's refusal to make portraits of women is not the reaction of a woman hater or any other type of misanthrope. He adopted the policy when he first came to New York—that was 40 years ago—and he did it to protect a principle. (He has stuck to it so strictly, by the way, that he has not made even one photograph of his wife or his daughter, and he loves them with the utmost depth of affection.)

This is how he came to make his decision. When MacDonald moved to New York he already had an established reputation, and in addition to that he had the determination to do nothing but absolutely honest work. He looked with hatred on glamorizing or prettifying a subject, and from experience he knew what difficulties and disappointments lay in his path if he were to attempt to do successful portraits of women—he had learned that they usually demanded idealized photographs rather than the character studies that he wanted to do. He also knew what a temptation it was to a photographer to take a short cut to success and affluence by the glamorizing route. His decision put that temptation definitely and permanently out of reach.

With that he adds one word to his maxim that good portraits must be planned. Portraits, he says, must be planned, and planned honestly.



The image at the left is not the product of a high-power microscope, but merely the "photogram" cast on a piece of contact printing paper by a goblet. In this case the light was held at a 60-deg. angle

Various positions of the flash lights are tried to get the best distribution of lights and shadows



Fantastic Photo Patterns Without a Camera

FANTASTIC and beautiful "photograms"—shadow pictures caught on photographic printing paper without the use of a camera—may be easily made of glassware and other common household objects with the help of one or more ordinary flash lights. Glass gives particularly striking patterns because of its capacity for catching and reflecting light, but any small articles with sharp detail may be used to produce strange designs drawn by light.

The object to be "photogrammed" is placed on a sheet of contact printing paper, which

is first covered with a sheet of orange or yellow cellulose tissue to prevent premature exposure. Room lighting must be dim. Draw the shades or, at night, put paper bags over the lamps. The flash lights, aimed from different angles, are then maneuvered over the object to produce an interesting pattern of shadow and light. Adjustment of the flash lights may be simplified by mounting them on regular photo-flood lighting stands, and shadows are cleanest when the source of light is adjusted as nearly as possible to a point.

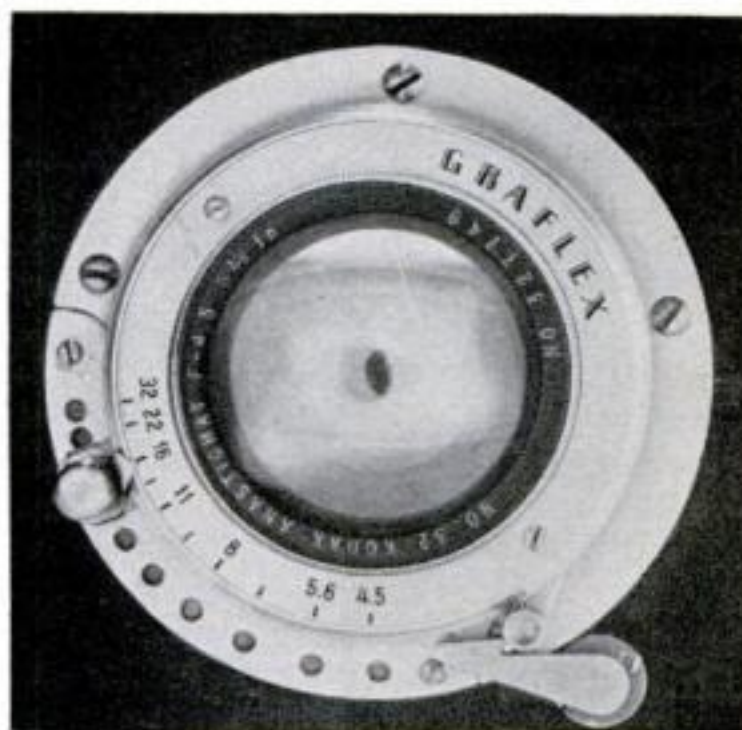
Exposure is made merely by removing the colored tissue and allowing the light to register on the paper. With ordinary flash lights and paper, exposure may run from one to ten seconds.

Shadow cast by two large wineglasses. The base of one is over the base of the other. The beam of light fell on the glasses at a 75-deg. angle

Orange or yellow tissue is laid on the sensitized paper to prevent premature exposure. The object may then be shifted about to get the best effect



FOR CAMERA USERS



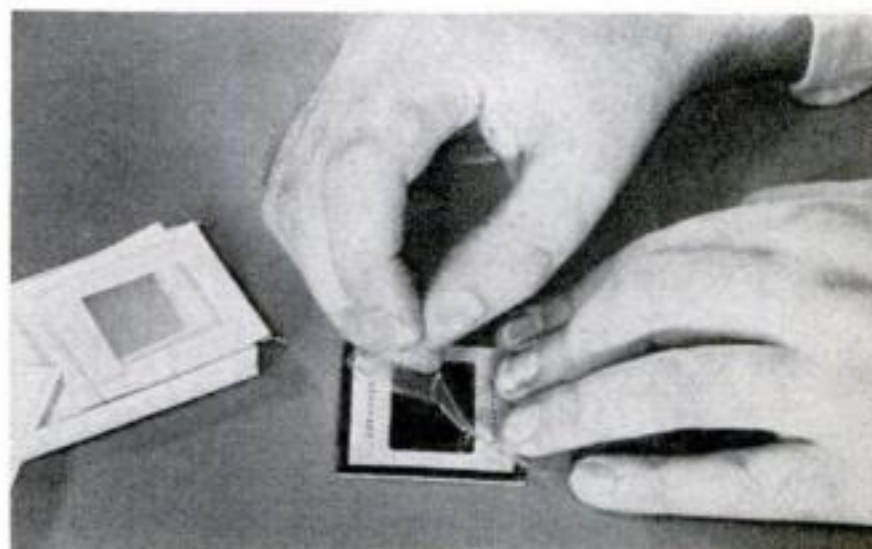
AN AUTOMATIC DIAPHRAGM is the outstanding feature of a new Graflex camera. It permits the subject to be viewed with the maximum possible brilliance, and with the plane of sharpest focus clearly defined, right up to the instant of exposure. The diaphragm is first preset to the value desired for exposure, and is then opened wide for focusing. The moment the release is snapped and before the shutter opens, it automatically returns to the first setting.

To users of single-lens reflex cameras this innovation offers a great advantage. When flash pictures are to be made, when pictures must be taken in bright outdoor light on beach or snow, when extreme close-ups are to be made of children or animals, the lens must be used wide open for good focusing and composing. The act of subsequently

stopping down the lens before exposure often causes the photographer to miss the vital action, shift focus, or ruin the framing. The new diaphragm eliminates this worry.

In addition, the new Graflex boasts a built-in synchronized open-flash mechanism which is claimed to be practically missproof. Contact to fire the lamp is made by a silvered spring attached to the mirror. When the mirror release is depressed, the mirror rises and ignites the lamp just before the curtain begins to close, giving an exposure determined by the duration of the lamp used. Using the new type SM quick-firing flash lamps, exposures may be made as fast as 1/200 second—more than ample to catch most animated subjects in the home. By using a Kodatron lamp, stop-action photos may be taken at 1/30,000 second.

COLOR FILMS and transparencies can be mounted by a new method that eliminates the use of glass, tapes, clamps, and other accessories. The mount is a clear protective covering banded with a self-sealing adhesive, which the manufacturer claims will not dry or crack with age. The adhesive is protected by a thin covering. This is peeled off, and the mount is pressed against the color film; the other side of the transparency is then protected in the same way. Twenty transparencies can be mounted by this method in ten minutes.



Little Brother

OF THE BIG HOLLYWOOD MOVIE CAMERAS

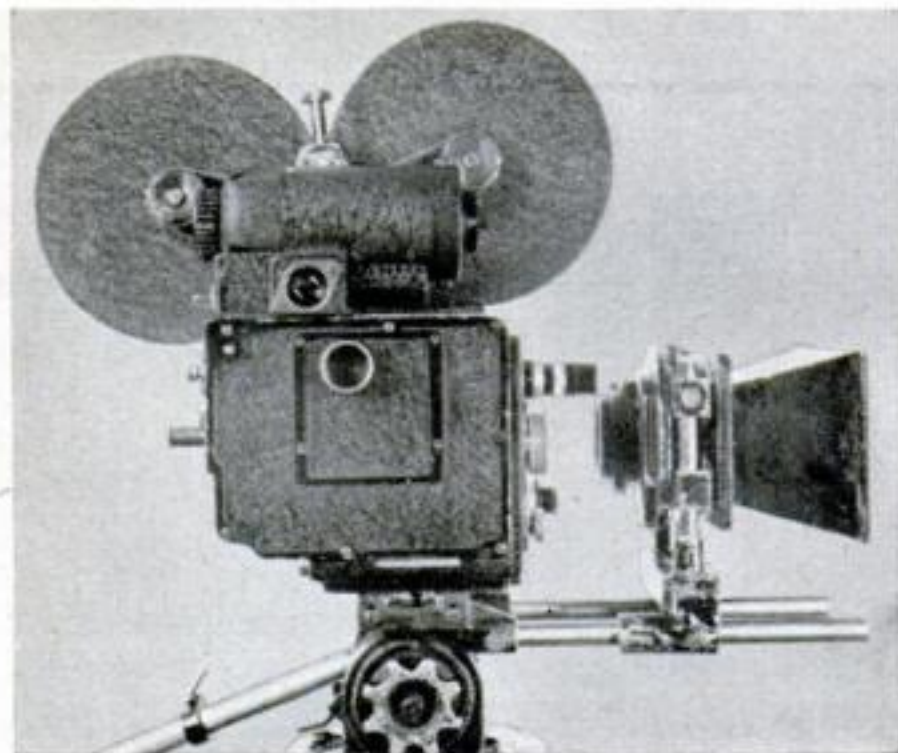
EMBODYING many of the refinements of professional 35-mm. movie cameras, a new 16-mm. outfit has been introduced, and the first model is being used by a Hollywood producer for commercial pictures. It is box-shaped, carries outside film magazines, and is fitted with a large four-lens turret.

The camera has two intermittent movements, which are interchangeable—one for microscopically accurate registration when shooting silent; the other a silenced movement for use when both sound and pictures are to be recorded.

In order to focus, the operator presses a button so that the head can slide out of the way. This movement brings into place behind the lens a focusing magnifier, mounted on the door and carrying at one end a ground-glass screen in the same focal plane as the film. The eyepiece is adjustable, and a highly magnified section of the scene may be viewed for critical focusing.

Operating controls at the rear include a manual control for a 170-deg. shutter and buttons to operate an automatic shutter dissolve. There are also footage and frame counters. To fade out, the operator simply touches a button, and the shutter closes during the exposure of 18" of film. For a lap dissolve, he releases the brake when the shutter is closed, reverses the motor to wind the film back to the start of the fade,

A side view of the new camera, which has a four-lens turret. Pilot pins and registering leaves hold the film in perfect alignment during exposure

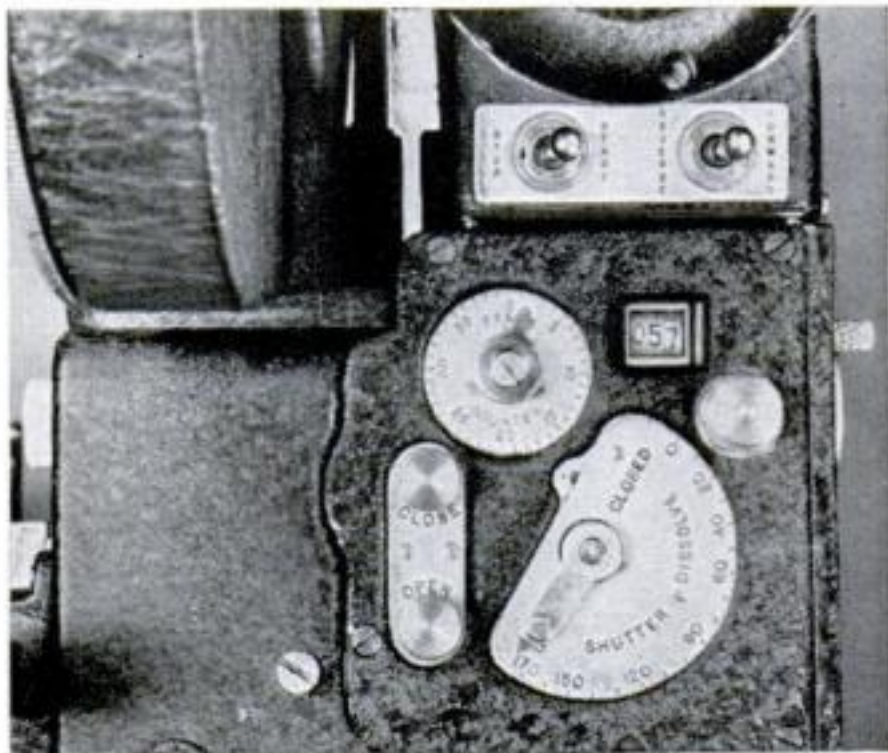


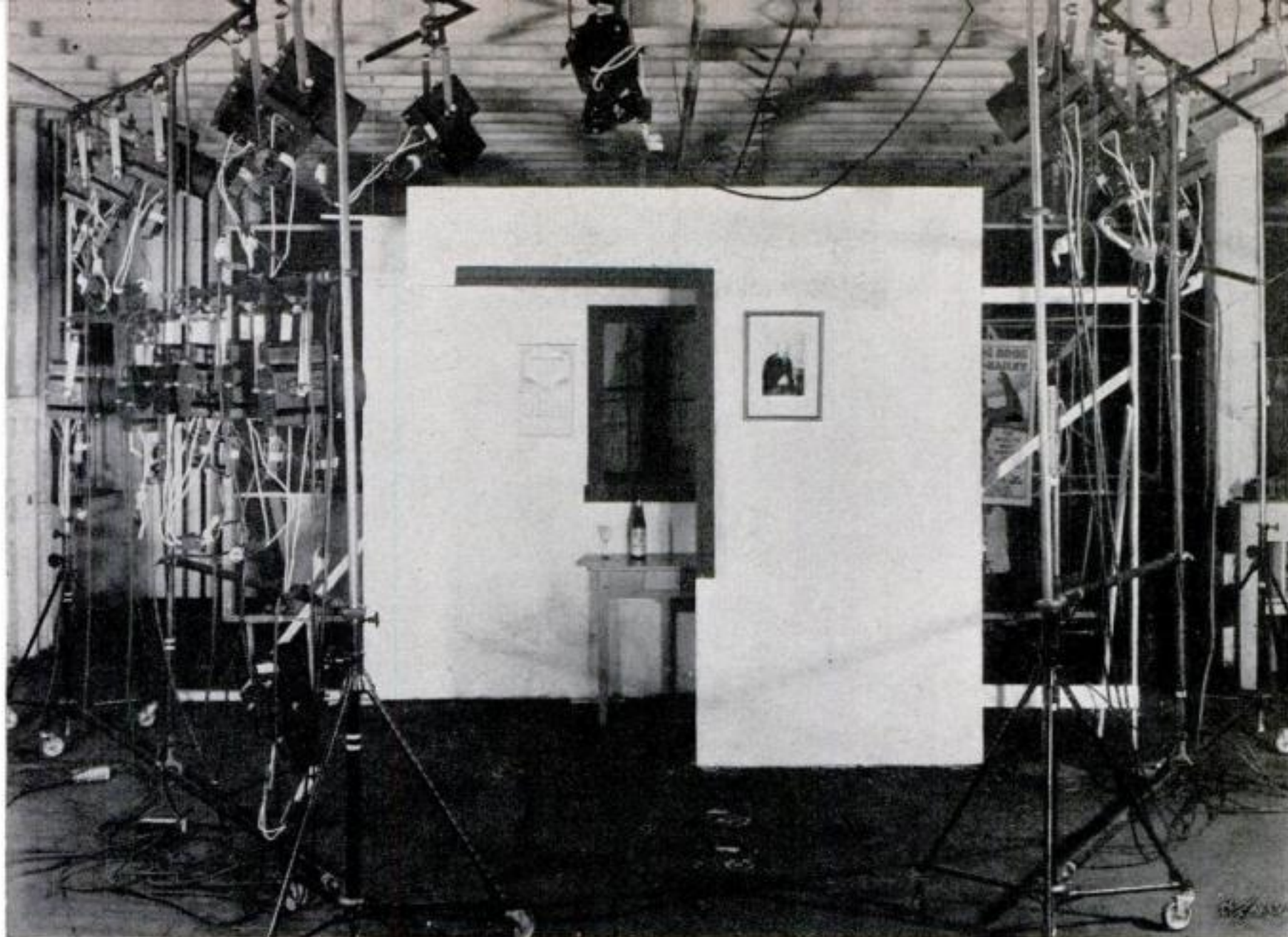
When the head of this 16-mm. camera slides aside, a ground-glass screen with an adjustable magnifying eyepiece moves into place for critical focusing

switches to forward, and then presses the fade-in button.

The camera is provided with two motors. One is of variable speed for silent shots and runs both forward and backward on 110-volt A.C. or batteries; the other is synchronous, operating only on 110 volts, and is used when recording sound. For stop-motion pictures, a third motor may be mounted in a space provided for the purpose.

How the controls are grouped. Dissolves and fade-outs can be made by simple manipulation. The camera has two intermittent movements and two motors





Banks of lights illuminate the set piecemeal in synchronization with a focus-changing device on the camera

Revolutionary Invention Gives Movies Great Depth of Focus

MOTION-PICTURE scenes in which both close-ups and background are simultaneously in sharp focus are possible with a system of photography invented by Dr. Alfred N. Goldsmith, of New York, and his associates, Harry R. Menefee, William Mayer, and Fritz Kastilan. Known as the "increased-range system," it makes it possible to use the full aperture of lenses as fast as $f/1.4$ and still keep all parts of the set in sharp focus, thus allowing actors to move freely about.

An optical-glass shutter revolving between lens and film operates synchronously with banks of lamps that flash on and off in rotation forty-eight times a second and successively illuminate the set from front to back. To the eye, the lighting seems uniform and constant. The optical shutter, however, continuously alters the focus of the camera in step with the lighting banks, so that near, medium, and far shots are recorded in each picture in rapid rotation. When projected, the scene appears naturally illuminated.

Two photos taken to illustrate the difference between ordinary and "increased-range" photography. Both were taken at $f/1.4$. The foreground figure is 8' from the camera; the background 18' away

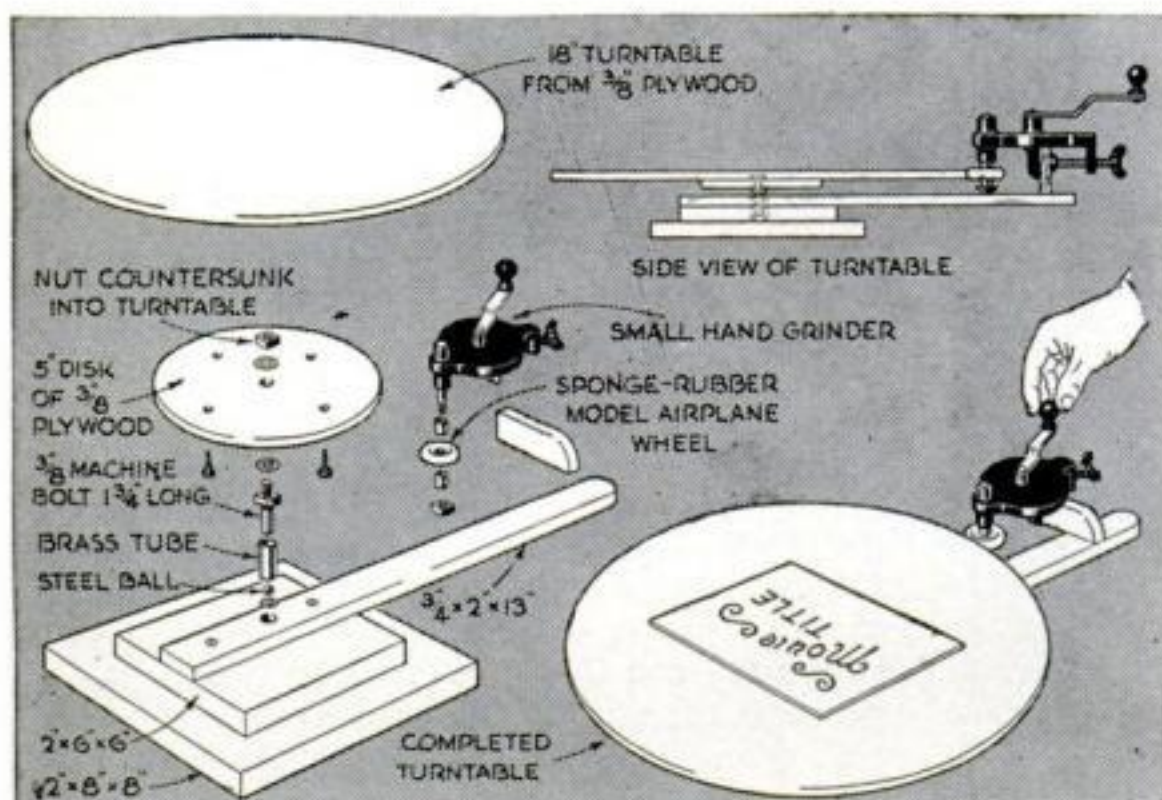




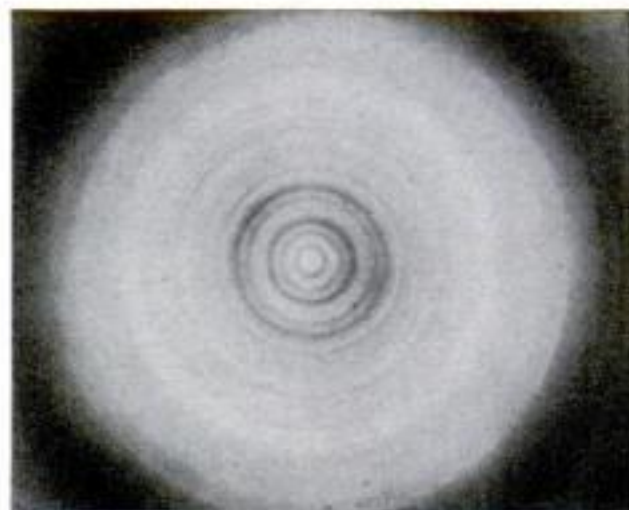
Homemade Movie Turntable Produces Trick Titles

BY SPINNING titles, still photographs, or small objects on a plywood turntable such as the one illustrated, the amateur movie maker can obtain unusual effects and duplicate many of the professional tricks used by Hollywood. The construction is made clear in the accompanying drawings. Screw the large 18" disk fast to the smaller one from underneath. The spindle is a bolt threaded at the end only, with the head cut off. File the lower end smooth to rest upon the steel ball without friction.

Because of its high gear ratio, the hand grinder gives a wide range of speeds and good control. The ball thrust bearing makes it easy to spin the table even when it is heavily loaded. A sponge-rubber tire from a model-airplane wheel is used for the friction drive, and greatly helps to eliminate vibration.—M. G. WINTERTON.



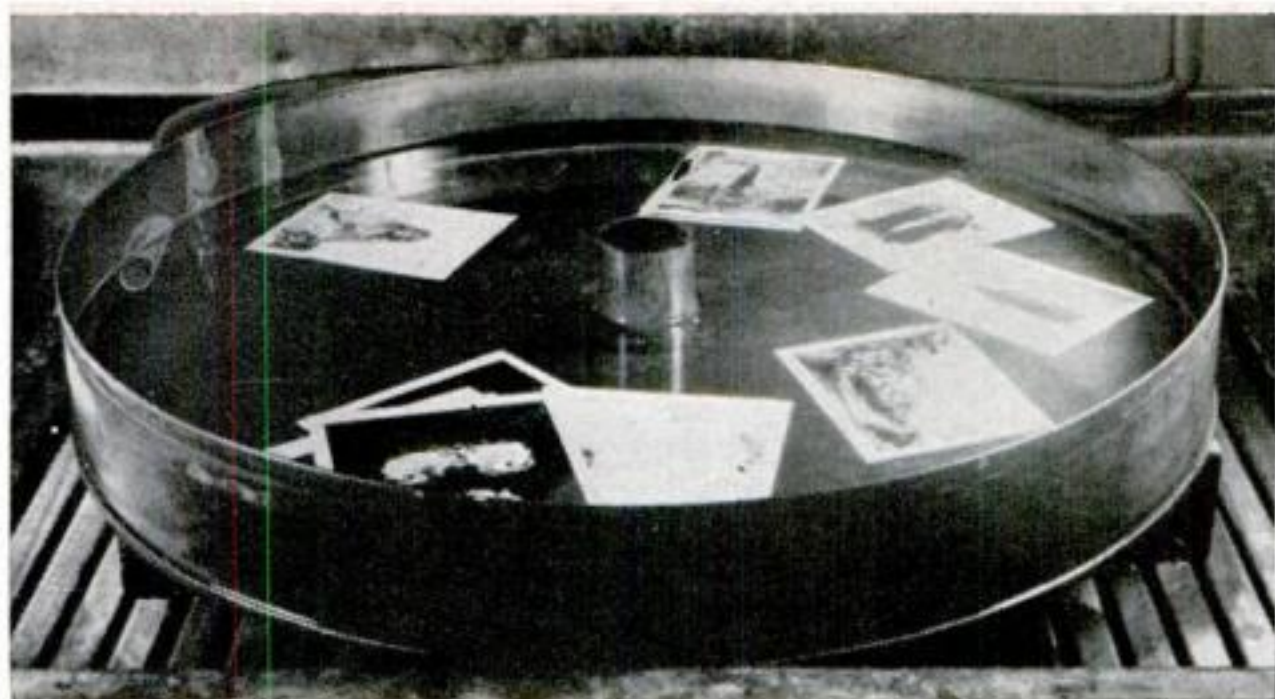
Construction of this home-movie title turntable requires no lathe. The plywood disks can, if necessary, be sawed out by hand. Place a small metal disk or washer under the steel ball to reduce friction at that point. Pressure of the sponge-rubber drive wheel against the turntable is adjusted by shifting the grinder slightly sideways.



Dried Spot of Ink Aids in Focusing Enlarger Accurately

IN FOCUSING an enlarger accurately, photographers often use a piece of dense film on which a number of scratches have been made. At rather large magnifications, however, this does not seem to give the desired degree of critical control. After a number of experiments, I found that by letting a large puddle of India ink dry on a piece of clear film, the ink develops a myriad of cracks, which range from very coarse ones

to those far too small to be seen with the naked eye. When this inked film is placed in the enlarger and projected, even at the greatest magnification, there are still many fine, sharp lines on which to focus. I have incorporated a piece of film thus treated in my negative carrier so that at any time, by sliding the negative carrier halfway out, I can focus the enlarger or check its focus very accurately.—A. L. ELLIOTT.



The amateur photographer can construct this simple self-siphoning print washer himself or have it made by a tinsmith. It keeps a flow of fresh water reaching all prints constantly, yet requires no attention. The 24" tank accommodates 8" by 10" prints. Monel metal, stainless steel, or galvanized iron may be used

Efficient Print Washer Flushes Itself Automatically

By **CHARLES H. COLES**

Chief Photographer of the American Museum of Natural History, New York

WASHING photographic prints correctly is so important that too much attention can hardly be given it. Experts agree that complete changes of water and thorough access of water to all prints are necessary, but to so wash prints by hand requires constant attention. The entirely automatic washer illustrated does the work perfectly and can be built at home in any size desired. Galvanized iron, if properly painted, may be used for all the parts.

To make the circular washer shown, a disk 24" in diameter is cut from the sheet metal and a $1\frac{3}{8}$ " hole cut in its center. A $\frac{1}{2}$ " wide strip is then soldered around the edge of this hole to form a flange on one side of the disk. One edge of another strip, $3\frac{1}{2}$ " wide and 76" long, is rolled over, and the strip then soldered around the outer edge of the disk to form the tank.

A piece of 1" pipe 4" long must be soldered into the $1\frac{3}{8}$ " hole. It may be necessary to shim up this pipe with sheet metal to obtain a close fit in the hole. Do not use pipe with an inside diameter of more than 1", as larger pipe will not create sufficient suction to operate the siphon.

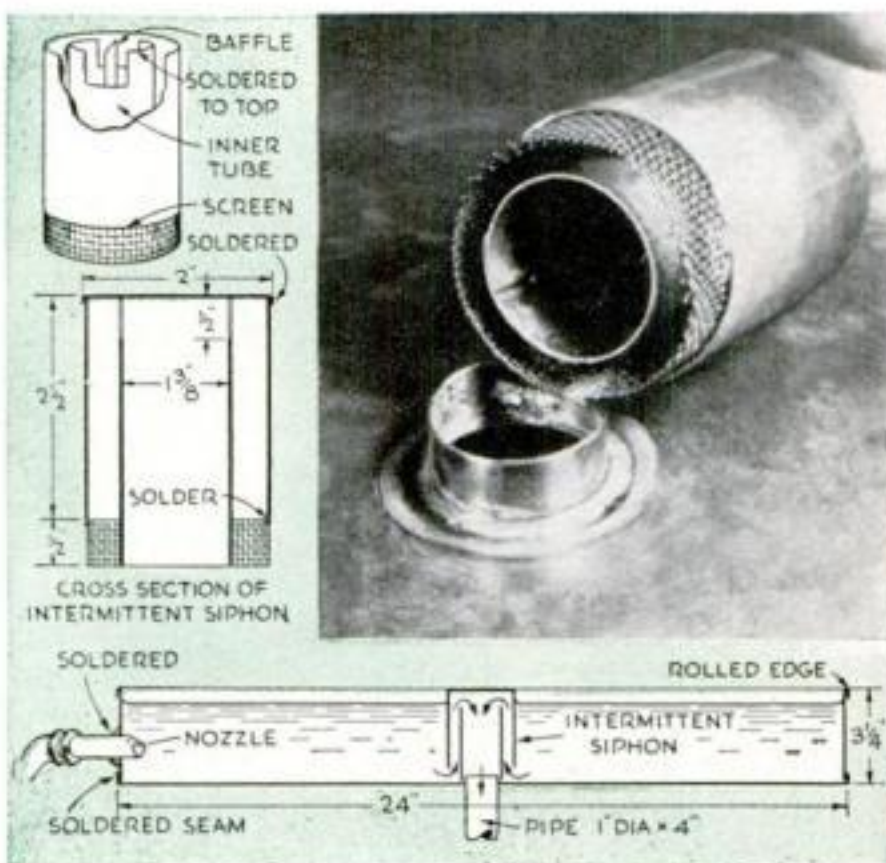
The water spout is a piece of $\frac{3}{4}$ " pipe 4" long with a hose connection soldered to one end. Hammer the other end to a flat nozzle and solder the pipe at an angle of about 30 deg. into a hole cut halfway up the side of the tank.

The automatic siphon consists of two metal tubes, one $1\frac{3}{8}$ " in diameter and 3" long and the other 2" in diameter and $2\frac{1}{2}$ " long. The $1\frac{3}{8}$ " tube has its top end cut down $\frac{1}{2}$ ", leaving only two lugs by which it is soldered to the center of a 2" disk, which in

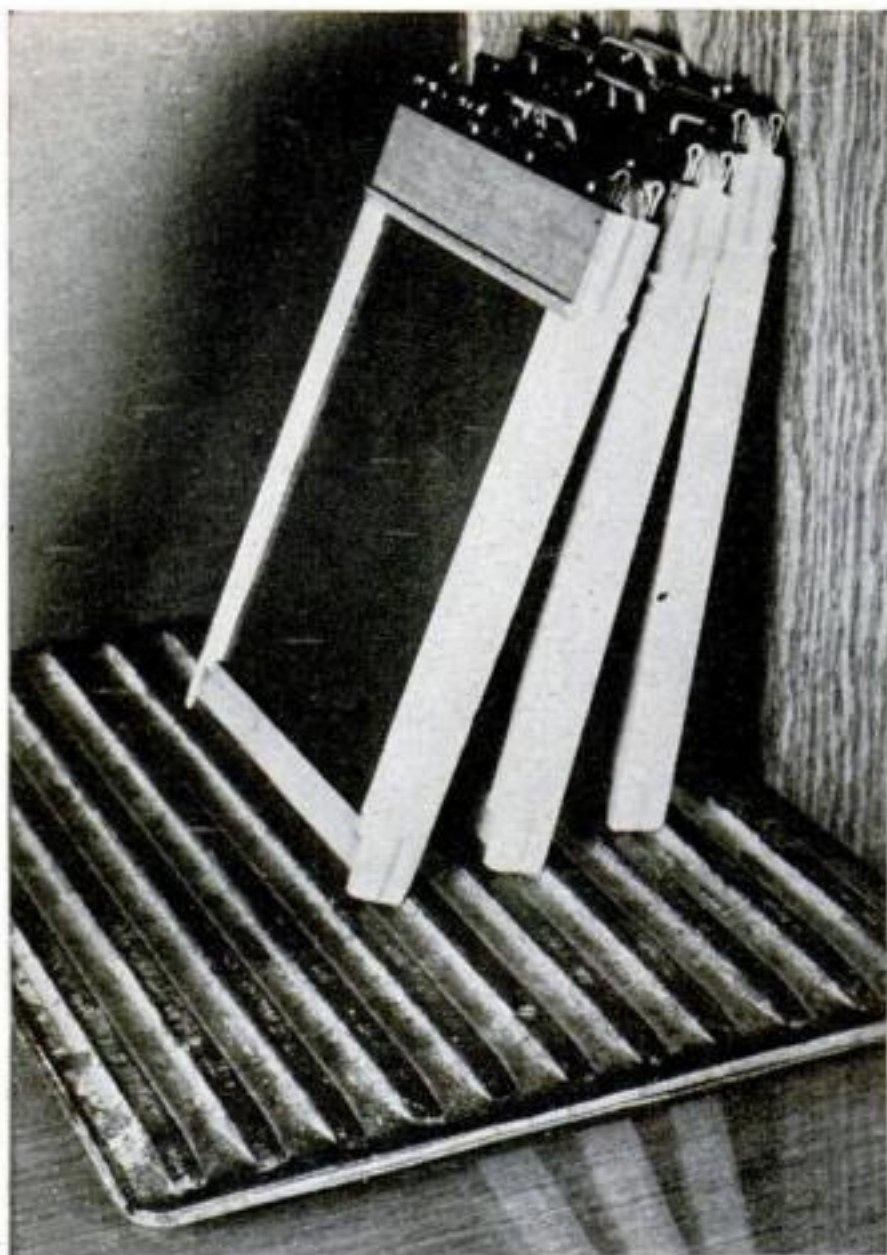
turn is soldered to the 2" tube. A piece of monel-metal screening is soldered to the bottom of the 2" tube to prevent prints from being drawn into it during the discharge of water.

To prevent the forming of a vortex that might destroy the siphoning action, a baffle plate, consisting of a piece of sheet metal $1\frac{3}{8}$ " by 3", is pushed lengthwise into the inner discharge tube. This breaks up any rotary motion of the water. A similar baffle may be needed in the lower 1" pipe also.

In use, the tank gradually fills with water, the prints moving around by the force of the jet. When the tank is full, siphoning begins and almost completely empties it, taking out the chemical-laden water. When the level falls below the end of the screened siphon tube, air enters, breaks the siphon, and allows the tank to fill again.



Above photo shows bottom of siphon tube and flange over which it fits. The tank repeatedly fills and empties, draining used water from the bottom



Rubber Battery Mat Prevents Film Holders from Sliding

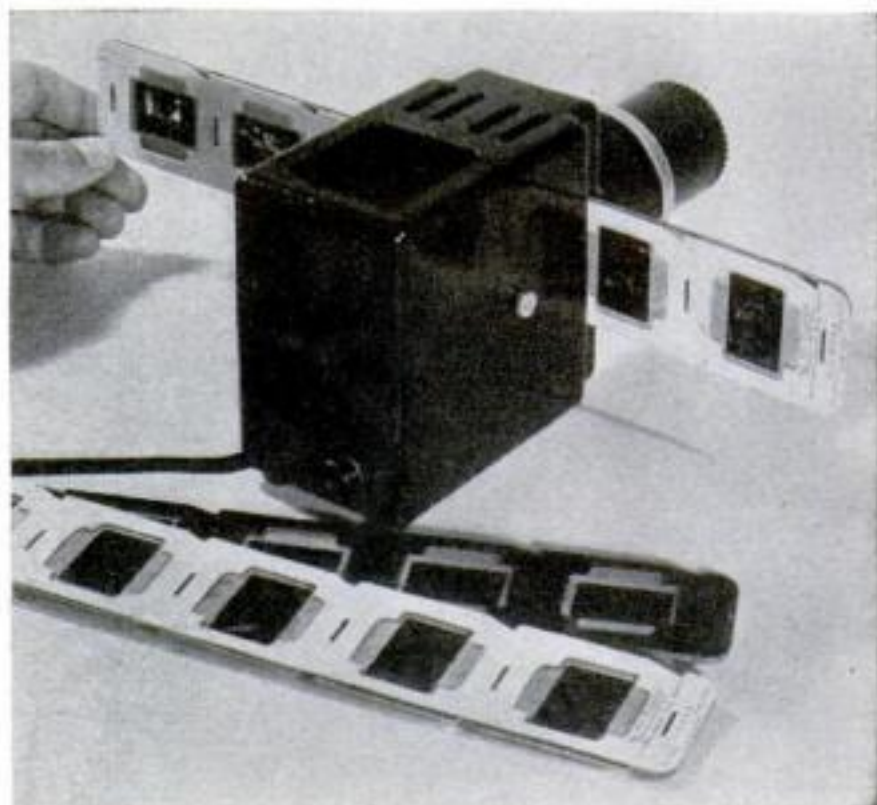
A CORRUGATED rubber mat of the type used under storage batteries is a convenience on the loading bench of a photographic dark-room. The cut-film holders stand up firmly in the grooves of the mat and may be readily located in the dark.

Making Developer Last Longer

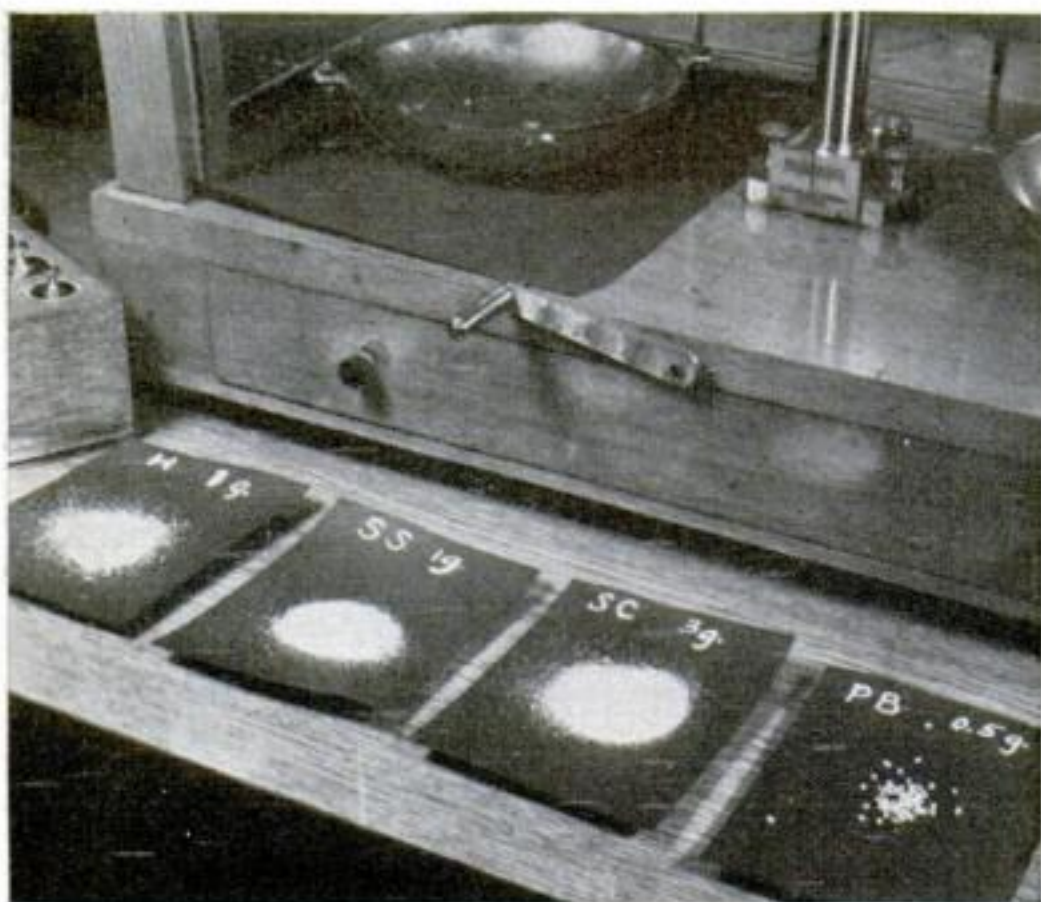
TO DELAY oxidation of a photographic developer, the bottle should be kept filled to the neck so that very little surface of liquid will be exposed to the air. One way to do this is to add glass marbles to make up for any small quantities lost during use.

Combination Projector Strip and Transparency File

FILING and viewing transparencies are both made more convenient with a combination film index and projector strip that is now on the market. Each strip takes six transparencies, and contains space for index data. A case is available for holding 36 strips.



Black Paper Slips Aid in Weighing Photographic Chemicals



THE BLACK paper sheets packed between pieces of cut film are useful in weighing chemicals, especially when you are making up a complicated or unfamiliar formula. It pays to save them for this.

Use as many of the sheets in each instance as there are ingredients, and mark on each with a red pencil the abbreviated name of one ingredient, together with the amount required. Put a blank piece of the same paper under the scale weights. Then weigh the required amounts of chemicals directly on the marked sheets. Both the quantities and the ingredients can be checked again after weighing, then mixed or dissolved in proper order with complete assurance that no error has been made.—C. C.

Snapshooting the Winter sport of millions



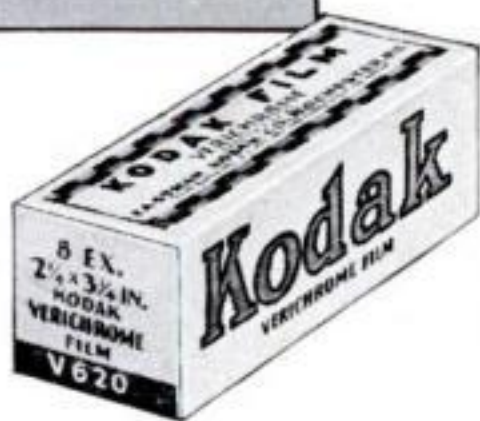
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Gus Keeps 'Em Rolling

(Continued from page 144)

held its lower end in contact with various parts of the engine. After a few minutes he raised his hand. "Switch her off," he told Ez. "There's nothing the matter with your bearings. That rap is coming from—or from somewhere near—your fuel pump. Ever had any trouble with it?"

"I've had trouble with pretty near every gol-dern gadget anybody's ever stuck on an automobile," Ez declared feelingly. "But I ain't never had any trouble with this particular fuel pump."

Gus examined the pump. "Clearance between the cam and the fuel-pump arm might cause that rapping," he said, "but that's not at all likely. Let's see, now—your fuel pump and your vacuum pump operate from the same rocker arm, but work off two different links in the fuel-pump housing. Start your engine again, Ez."

Ez did as he was told. "Switch her off," Gus said after a few seconds. "I've got it. Those two links are hitting against each other! That's what's been making that noise. Probably the trouble is caused by a broken diaphragm."

"So that's it, hey?" Ez said. "I ain't a very good guesser, am I? Well, I guess puttin' in a new diaphragm ought to fix it up."

"It might," Gus said. "And then again, it mightn't. You just saw me put a new fuel pump on Doc Foley's car. Your bus needs one a lot worse than his does."

"I mighta knowed you'd manage to sell me somethin' before I got outa this place," Ez grumbled. Then he grinned broadly. "Sure—put it on, Gus. Whatever you say about automobiles is jest as good as Scripture to me!"

After Ez had driven away Gus glanced at the shop clock. It was close to eleven. He went into the office and found Joe Clark nodding over a ledger. Poking his partner playfully in the ribs he told him that he'd better wake up and go home.

Joe yawned extensively. "How about you?" he wanted to know. "You've worked about thirteen hours today."

Gus grinned at him. "Don't worry about me," he said. "We've got a lot of good customers who have a lot of not-so-good cars, and we've got to keep 'em rolling—that's our job! Drive Doc Foley's car over to his house on your way home, will you, Joe? I was going to do it myself, but I've just had a bright idea for that gadget of mine, and I want to do a little work on it before I hit the hay."

"I WAS BOUND AND GAGGED AND LEFT TO DIE!"



A true experience of JOSEPH J. KARES, Charlestown, Boston, Mass.



"THUGS HELD ME UP one bitterly cold night as I left our docked lumber ship," writes Radio Operator Kares. "After taking what cash I had, they left me bound and gagged in an inky dark alley between great piles of stacked lumber.

"FURIOUS STRUGGLING only tightened my bonds. My arms and legs grew numb with cold. My plight was desperate! Then, remembering my flashlight, I managed to reach it . . . started flashing SOS against the top of the lumber.



"FOR MORE THAN AN HOUR I kept signaling. Half dead with cold . . . about to give up hope . . . I was at last rescued by two officers from my ship. If it hadn't been for those dependable 'Eveready' fresh DATED batteries I would have been a goner.

(Signed) *Joseph J. Kares*

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FREE MANUAL, with valuable hints on how to use and care for saws, tools and files, is yours for the asking. Write for your copy today.



Tanks Can Be Destroyed

(Continued from page 79)

and find the enemy and destroy him before he strikes. It embodies the old military principle that the best defense is to hit the other guy first.

As planned today the tank destroyer battalions will be as innocent of self-protection as the naval destroyers and light cruisers of the battle fleet. With its thirty-six 75's and eighteen 37's, the battalion as now set up carries defensively eight 37-millimeter anti-aircraft guns and .50 caliber machine guns for protection against ground- strafing planes. For advance reconnaissance, it has ten light tanks, armored, but the main body is for speed and striking power alone. Its counterpart exists in no army in the world, and it is a typically American conception. To paraphrase the oft-quoted Civil War general, it will be out to get there firstest with the mostest guns.

Modern Troop Transports

(Continued from page 85)

landing boats, and every precaution is taken to assure the safety of the personnel. Life preservers are adjusted and life rafts made ready to put over the side.

In the nation's defensive set-up there must be considered our ability to land troops on foreign soil.

Master Traffic Plans Urged to Ease Defense Congestion

TRAFFIC CONGESTION threatens to create a new bottleneck in the defense program, according to Capt. C. Reynolds Weaver of the War Department's general staff.

"We soon will have 250,000 military motor vehicles on the nation's highways," Captain Weaver explains. "They range in size from the quarter-ton jeeps to 7½-ton trucks and even larger units. What happens when traffic control fails during military operations has been demonstrated tragically in France."

One way of breaking this potential bottleneck, Captain Weaver points out, is through master traffic plans developed by many cities and communities. Cooperation between military and civilian authorities can prevent conflicts between convoys and civilian traffic and relieve congestion around key industrial plants and on important routes.



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YOU CAN FEEL THE SMOOTHNESS OF A FINE CAR...



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takes the guesswork
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The new 1941 CASCO Gluing Guide tells what glue to use on every type of job... gives complete directions for all 3 CASCO adhesives.

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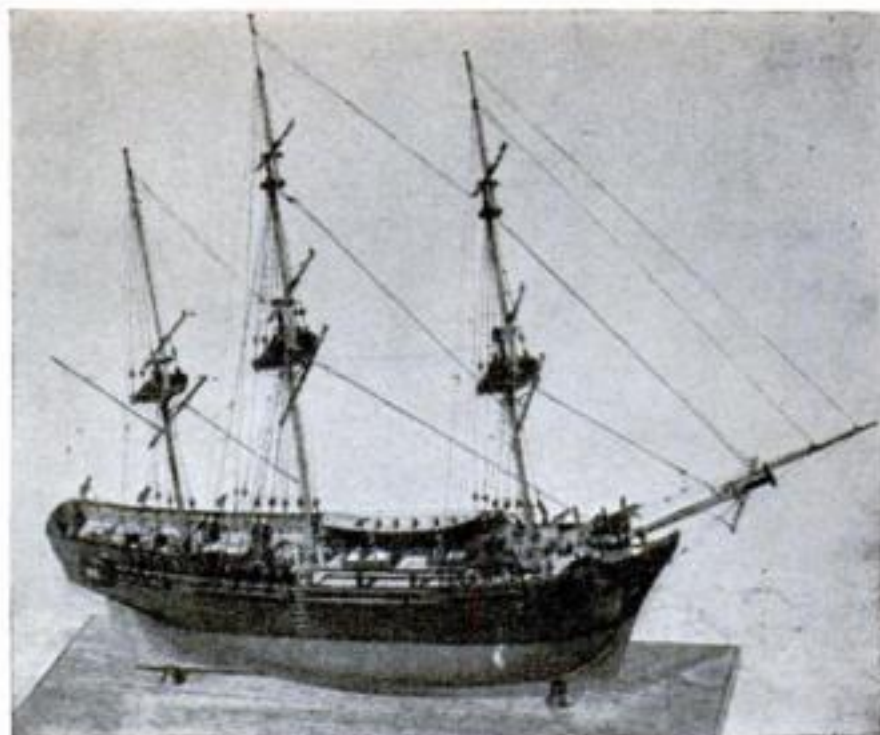
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Two Kits for Building Models of H.M.S. "Bounty"

IMMORTALIZED in books and film, the *Bounty's* story of mutiny and men against the sea appeals to every one. Here is a subject for the model maker's art!

POPULAR SCIENCE now offers two kits of this famous ship. The beautifully detailed model shown above is one any craftsman would be proud to show as his handiwork. About 22" long and 17" high, scaled 5/32" to the foot, it is made from our new kit No. 14S, which includes plans, a precision-shaped, hollowed hull, all materials, and a full set of almost 400 finished fittings. The price is \$19.00*.

Our kit No. Z (\$1.60) contains materials, but no finished parts, for a very much simplified model of the same ship, 11½" long.

A stamped, self-addressed envelope will bring you a complete list of our kits.

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EXTRA STARTING ABILITY



The Outstanding Characteristic of ALL DELCO Batteries

The final test of a battery is dependable performance during the winter months, when zero and sub-zero temperatures make cars hard to start.

It is during these months especially that *extra starting ability*—an outstanding characteristic of all Delco batteries—stands Delco battery owners in good stead.

There are more than six million users of Delco batteries. More than six million cars, trucks and buses will start surely and dependably this winter because of this *extra start-*

ing ability that Delco batteries provide.

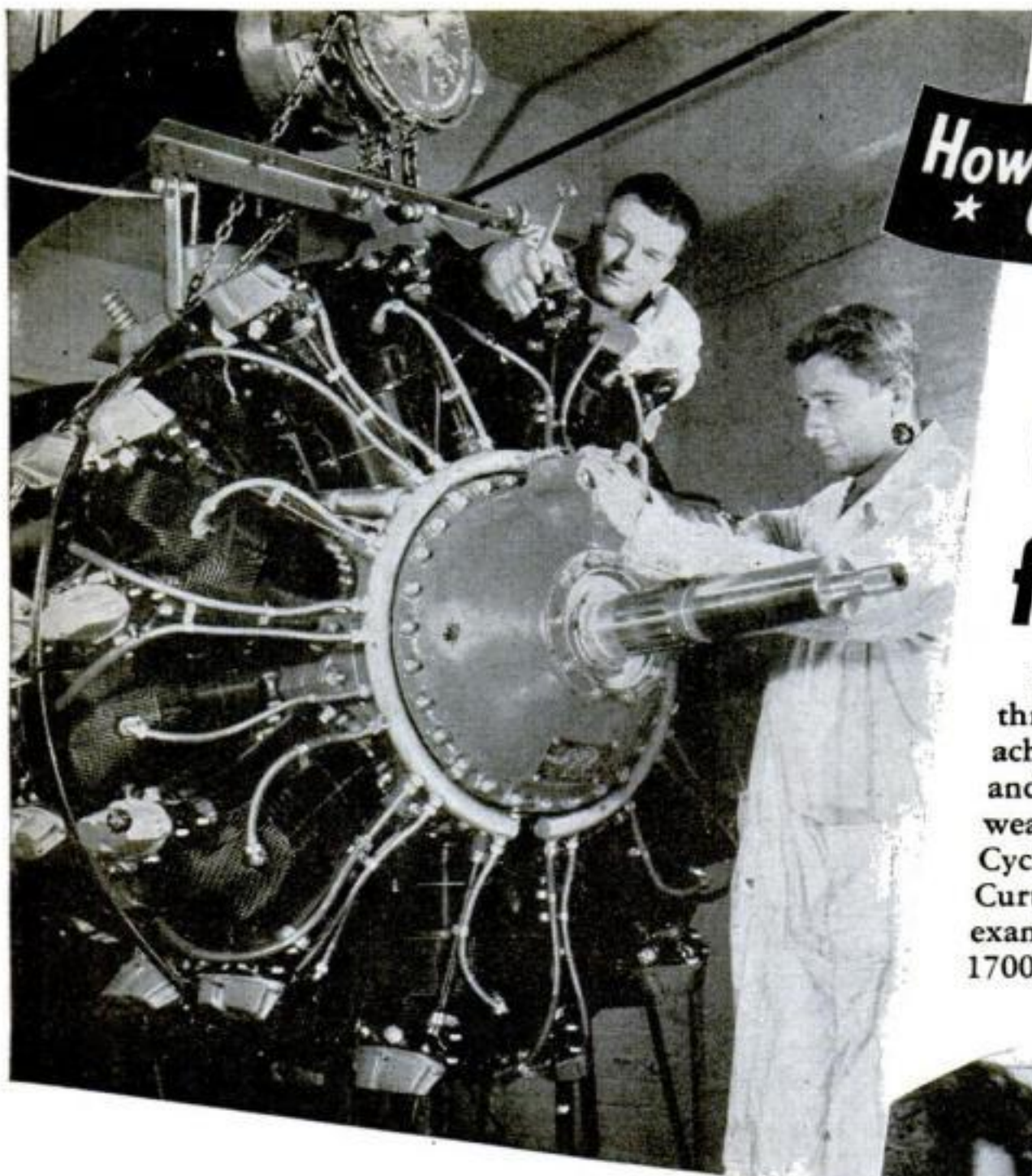
And this year, as in years past, more than 43 per cent of all new cars sold are equipped with Delco batteries. For America's leading automotive engineers have put their stamp of approval on Delco batteries by selecting them for original equipment.

Get a Delco battery for your car. Your Delco battery dealer will show you one that is exactly right for your requirements, whatever make or model car you drive.

Replace with a
DELCO Battery

Delco-Remy

World's Largest Manufacturer of Automotive Electrical Equipment



How *Atlas* **SERVES THE NATION**

No. 2 in a Series of Messages showing how Atlas helps in the Defense Program.

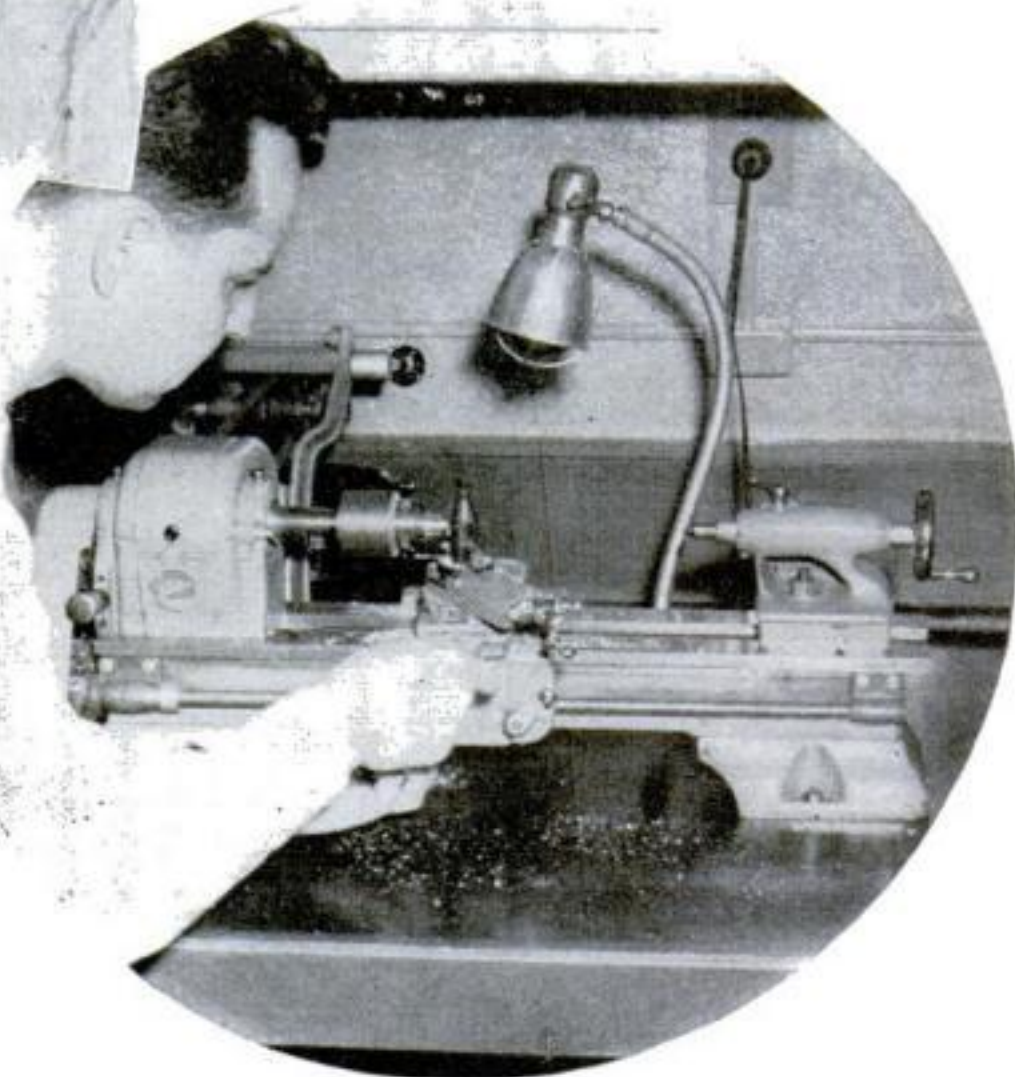
CYCLONES for DEFENSE

Every mechanically-minded American thrills with justifiable pride at the achievements of the nation's engineers and craftsmen in building mighty weapons for defense. This Wright Cyclone 14 that powers the famous Curtiss Dive Bomber is a typical example—a 14 cylinder double-row 1700 HP radial-type air-cooled engine.

Other engines of the Wright Aeronautical Corporation power Navy Trainers, Army Tanks, Boeing Flying Fortresses, and the huge Douglas B-19.

Unvarying exactness for absolute dependability is the keynote of Wright production—to insure safety of pilot and equipment and to maintain the reputation of Wright engines for unfaltering service through millions of flying miles year after year.

With *precision and production* as the goal, America is building an impregnable defense. We are proud of the many helpful ways Atlas machine tools are serving the nation.

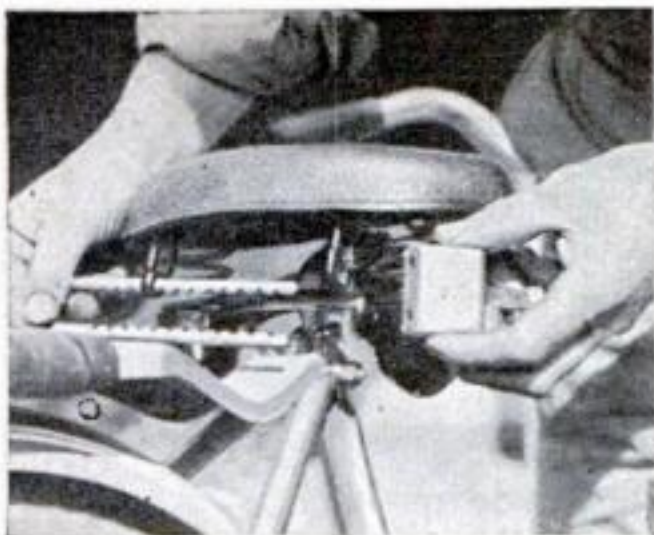


The Atlas Lathe is in regular use in the materials testing laboratories of the Wright Aeronautical Corporation.



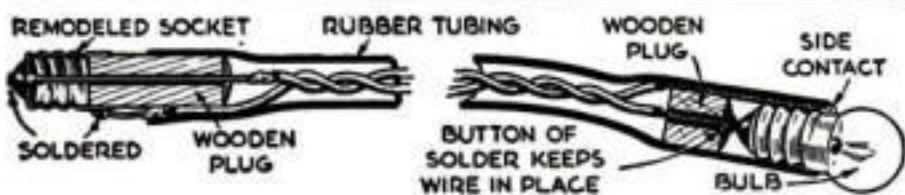
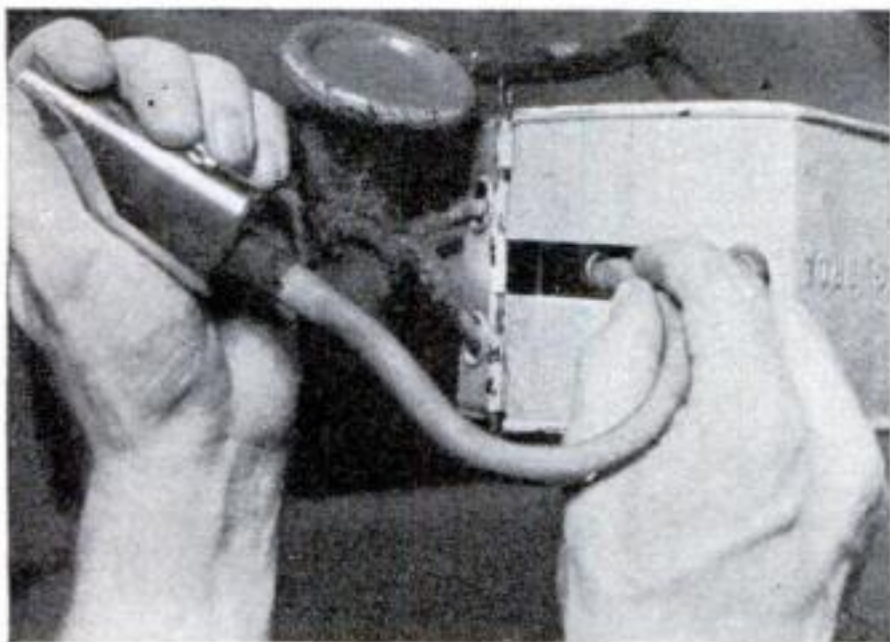
ATLAS PRESS COMPANY
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Bicycle Lock Held Safely Underneath the Saddle

I WAS recently confronted with the problem of providing my daughter's new bicycle with means for carrying a bicycle lock in such a manner that it would not interfere with her riding, would not scratch the enamel, could not be removed by meddlesome persons, and would not rattle. To do this, I obtained two Ford brake-rod clevises, ran an ordinary 5/16" tap through the finely threaded hole in each, and screwed them on the protruding threads of the two bolts at the rear of the saddle. The lock is then carried as shown.—GEORGE GAHAGAN.



Rubber Flashlight Extension Enters Small Openings

A FLEXIBLE flashlight extension of great utility is easily made from a length of rubber tubing, a piece of rubber-insulated lamp cord, two wooden plugs, and a flashlight bulb socket. The tubing should be 3/8" in outside diameter and not too hard. The glass and filling material of the flashlight bulb are cleaned out, and the connections made as shown.—F. C.



There are better reasons today than ever before for saving things made of metal. Many articles in and around the home *can't be replaced*, or they're scarce, due to the heavy demand of national defense.

That makes Kester Metal Mender one of the most important items in any home workshop, because it fixes just about anything made of metal, quickly and permanently. Kitchenware, lamps, wire baskets, ornaments and various equipment are just a few of the articles you can repair, and save. Kester is easy to use, no muss; no guesswork; just apply heat and, the job's done.

If you've never done metalcraft at home, try it and see how interesting it is. Kester Metal Mender *makes* as well as *mends*. Get acquainted with Kester; fill out the coupon and mail today, for generous FREE sample of the solder and booklet, "How to Use It."



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Please send me free sample of Kester Metal Mender and "How-to-Use-It" Booklet.

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• • • Which is another way of saying that millions of files in the hands of millions of patriotic workers are doing a tremendous bit toward National Defense—on ships, planes, tanks, trucks, guns, shells and what not.

Above, for instance, you see one of four hand-filing operations employed in the making of 3-inch anti-aircraft shells. The file is a Nicholson.

For speed and accuracy, the surest, smoothest, sharpest cutting and most uniform files are needed. That's why each week hundreds of thousands of Nicholson and Black Diamond files are "entering the service"—in both manufacture and up-keep of defense equipment; in indirect defense activities—mining, lumbering, manufacturing, etc. Available through mill-supply or hardware houses.

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(Also Canadian Plant, Port Hope, Ont.)



Early Colonial pine chest, plan 308A, 25¢

Our Tested Blueprints Help Solve Your Gift Problems

LESS than two months to Christmas, and time to start making those gifts you've been thinking about! If you're puzzled as to what to build, perhaps the following list will be of help. Our tested blueprints will make your work easier and enable you to do it more quickly, whether you're building a bird house or a racing sailboat. And, of course, if you have a workshop fan on your list, you can give the blueprints themselves as a gift.

If the article you wish to make isn't listed here, it may appear in our blueprint catalog, which you can obtain by simply sending us a stamped envelope addressed to yourself.

GIFTS FOR MEN

Cabin Cruiser, 17' long weighs 750 lb., for use with inboard or outboard motor from 2 to 10 h.p., 356-357-358-359-R	\$1.50
Canvas-Covered Duck Boat, 13' 6" long, 279-R	.50
Clipper Ship Model GREAT REPUBLIC, 31½" hull, 272-273-274-R	1.25
Colonial Writing Desk, 21	.25
Confederate Raider ALABAMA, 21½" hull, 335-336-337-R	1.50
Locomotive, HO gauge, Hudson type, 14" long, driven by 6-volt motor, 329-330-R	.75
Outdoorsman's Lightweight Trailer, 10' long, 4' wide, 4' 9" high, kitchenette on back, 300-301-R	.75
Racing Sailboat BLACKCAT, 13' 4" long, weighs 250 lb., Marconi rigged, 321-322-323R	1.00
Sandpaper Cabinet, Sawhorse, Hand-Screw Rack, Tool Rack, and Machinist's Hand Vise, 368A	.25
U. S. Battleship TEXAS, 3' long, 197-198-199-200	1.00
Utility Rowboat, 13' long, 224-R	.50

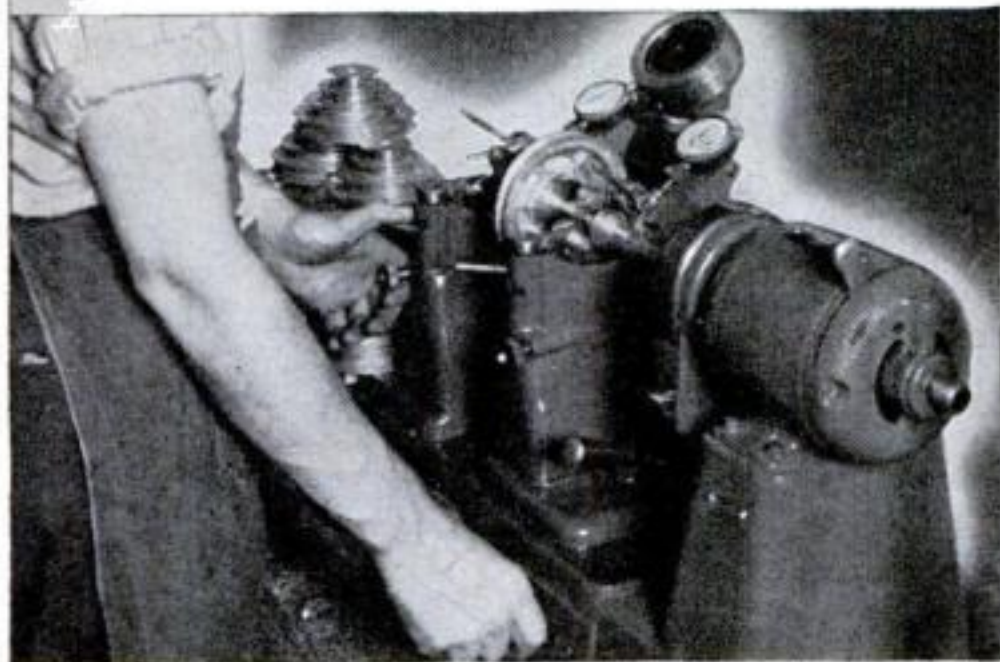
GIFTS FOR WOMEN

Aluminum Relish Dish, Turned Nautical Match Holder, Daylight Screen for Color Slides, 409A	.25
Folding Wall Brackets (turned), Treble-Clef Bud Vase (metal or plastic), Vacuum Cleaner Attachment Rack, 408A	.25
Kitchen Table Cabinet, 27	.25
Mirror Frame, 246A	.25
Modernistic Folding Screens, 91	.25
Mosaic Serving Tray, 297A	.25
Queen Anne Dressing Table, Stool, and Mirror, 295A	.75
Rolled-Edge Metal Tray, Table Centerpiece for Easter (rabbit hitched to wagon), Bronze Hammer, 407A	.25
Sewing Cabinets, Priscilla and Modern, 31	.25
Silverware Chest on Stand, 256A	.25
Spool-Turned Table, 22" by 48" top, 290A	.25
Tile-Top Tables, wood and metal, 249A	.25

(Continued on page 228)

How "DYNAMIC BALANCING"

makes Better Drill Presses



To insure true running of revolving parts, such as pulleys and wheels, Delta uses a special operation known as Dynamic Balancing.

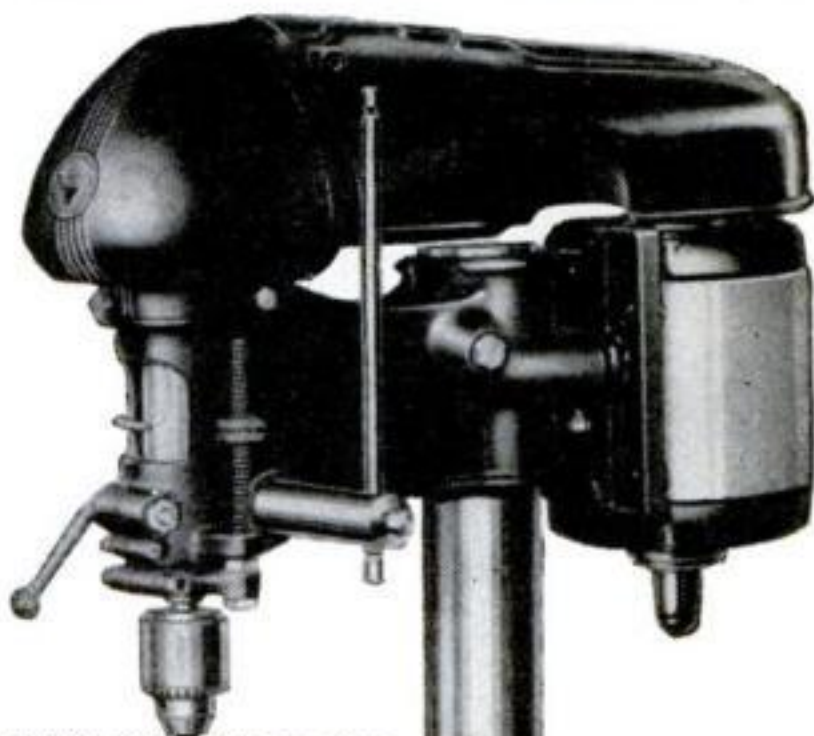
Many drill presses have the pulleys Statically Balanced, a method by which the pulley is mounted upon a shaft and then placed between two horizontal parallel knife edge supports so that the heavy part of the pulley will naturally swing to the bottom. The "heavy" part of the pulley is thus found and by means of a drill the excess metal is removed so that the pulley is better balanced. Static Balancing is not good enough for Delta drill presses because it does not balance accurately enough.

Dynamic Balancing, done with the special delicate electrical apparatus shown in the photograph above, locates and corrects *all* heavy spots—so that the revolving part is in perfect balance.

Therefore, in Delta drill presses you are assured of absolutely true-running, vibrationless operation which means lifelong accuracy for you.

Dynamic Balancing is another Delta feature—an extra, costly operation which is done for you—a feature impossible to see with the eye but one which assures you satisfactory operation when you buy Delta machines.

For the full story of Delta's "hidden quality" send coupon for latest Delta catalog.



Only the Delta 14" drill press gives you the combination of BOTH Self-Aligning Drive and Free Floating Spindle that guarantees accurate alignments. Other features include: "Sealed-for-Life" Ball Bearings; Graduated Quill; Adjustable Depth Pointer; Tilting Table with Index Pin and many others.

Takes drills up to 17/32" in diameter; also all standard wood bits with 3/4" shanks; can be used for boring holes up to 2" with standard multi-spur bits. Can be used for mortising, sanding, routing and grinding.

SEND FOR CATALOG

Write for the new Delta catalog which is a complete guide book to power tools. It not only lists the entire line of Delta "Quality" wood and metal working tools—but shows you the important points to look for in all power tools. It illustrates and explains the advantages of the many hidden features of design and construction that make for long, better service in power tools. (Also send for Project Book 8 crowded with new projects, including working drawings, photographs and full instructions.)

DELTA
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The Delta Manufacturing Co., (Dept. 683N)

600-634 E. Vienna Avenue, Milwaukee

Gentlemen: Send me the latest Delta Catalog listing the complete line of Delta Lathes, Circular Saws, Band Saws, Jointers, Scroll Saws, Shapers, Sanders and Drill Presses. ☐ I enclose 10c (stamps or coin) for which please send me the new Delta Project Book No. 8.

Name.....

Address.....

City.....State.....

☐ Check here if you are a Delta user now.



In all parts of the country, housing for defense workers—both military and civilian—is providing a clear picture of the home of tomorrow. These homes are built by **prefabrication**—the building method by which centralized fabricating plants construct floor, wall, ceiling and roof sections which are later assembled on the building site. Prefabricated homes are comfortable, attractive homes, *livable* in every respect.

Precision-Built Construction leads the field of prefabrication in speed... quality... economy and permanence. *Precision-Built Homes are completed in from 6 to 30 days.* Precision-Built—pioneered in 1935 by Homasote Company—has already been used in \$6,000,000 of architect-designed, *private* homes.

This method features the use of Homasote—the oldest and strongest insulating and building board on the market—in large sheets (up to 8' x 14'). Experience proves these big sheets are essential to satisfactory prefabrication.

Homasote's large sheets eliminate ugly batten strips and wall joints... give you a home snug... easy to maintain... one which requires only the smallest heating plant. With Precision-Built Construction, your home is any size, any style you desire. You have complete freedom of design, using your own architect, or one of our architect-designed plans.

At the end of the present national emergency, 67 fabricating plants throughout the country will service local architects and builders with Precision-Built Construction for private homes. Through this production line method, complete homes—ready for occupancy—will be turned out in one to three weeks.



Homasote wholesalers and retailers are cheerfully co-operating with the National Defense Program—at personal sacrifice. Although our capacity is exceeded at the moment by emergency orders, we are rapidly increasing our facilities.



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1941 Home and Workshop Index Now Ready



YOU can save yourself hours of searching through your back issues of **POPULAR SCIENCE** for some desired information by ordering a copy of the Home and Workshop Annual Index, now available for 1941.

Every article on home building, woodworking, craftwork, shop methods, house repairs, model making, radio, automobiles, and the like is not only listed alphabetically, but also carefully and completely cross-indexed. Just send 10 cents to Popular Science Home and Workshop Index, 353 Fourth Avenue, New York, N. Y., and inclose a long, legal-size (No. 10) envelope addressed to yourself. A limited supply of the 1940 Index is also available. Send 20 cents if you wish the indexes for both years.

Tested Gift Suggestions

(Continued from page 226)

GIFTS FOR BOYS

Bobsled, 9' 5" long, chassis of spruce and plywood, 362A .....	.50
Clipper Ship in Bottle, 121-122 .....	.50
Cruiser U.S.S. INDIANAPOLIS, 12" hull, 216 .....	.25
Kayak (with sail, etc.), 192-193-194-R	1.00
Kite Reels, Ball-Bearing, 290A .....	.25
Projector for Photos and Pictures, 259A .....	.25
Racing Yacht, 20" sailing model, 48-R .....	.50
Toy Fire Engine, Sprinkler, Dump Truck and Tractor, can be made of scrap, 101 .....	.25
Toy Lathe, Drill Press, Saw, and Jointer, 113 .....	.25
Treasure Chests, with metal bindings, 78 .....	.25

GIFTS FOR GIRLS

Bud-Vase Holder of Metal and Glass, 288A .....	.25
Colonial Design Doll's House, 72 .....	.25
Doll's House Furniture, 73 .....	.25
Flowerpot Stand (38½" high) and Novel Modern Lamp, 317A .....	.25
Knitting Bag with Wooden Frame, and Book Ends, 267A .....	.25
MAYFLOWER, 24" model, 83-84-85-R	1.00
Sewing Kit, Pelican Design, 255A25
Turned Costume Jewelry, 275A25

Popular Science Monthly

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For apartments-dwellers and for all men and boys with limited space in which to work, Lionel "OO" is ideal. Only about half the size of "O" gauge, yet containing just as much fine detail, realism and dependable performance. Read all about "OO" gauge in the new Lionel Catalog. See Lionel "OO" gauge trains on display at your dealers.

LIONEL

BIG NEWS FOR LIONEL RAILROADERS

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New Cars! New Engines! Exciting New Equipment!**

Send at once for a copy of the new 1941 Lionel Catalog and feast your eyes on the Lionel line of all time—the greatest array of scale model railroad equipment Lionel has ever manufactured! New, low, long, highly detailed, authentic-model passenger coaches. New engines. New train combinations. New, realistic accessories. New action features. A new high mark in fun, thrills and excitement for Lionel railroaders. Get the complete story. Don't wait. Send for your Lionel Catalog today.

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Co-Author: The Leica Manual, Miniature Camera Work.

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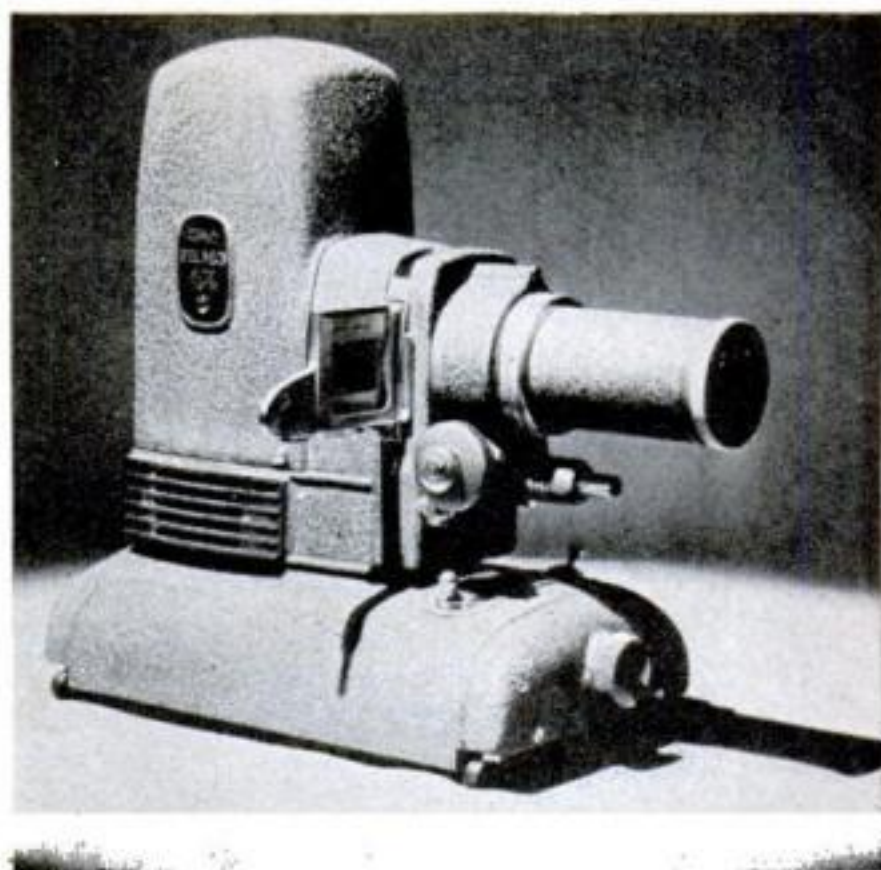
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Bell & Howell



New Photo-Slide Projector Has Lamp Placed Base Up

WIND-TUNNEL cooling, which is provided by a motor-driven fan, and an especially efficient lamp are features of this new slide projector for mounted 2" by 2" transparencies in color or black and white. The lamp is placed base up in order to keep its sides clear of black deposit, thus avoiding any reduction of light. Lamps of 500, 750, or 1,000 watts may be used, and the projector operates on 100-125 volts, A.C. or D.C.



Movie Editor's Fading Kit

ODD movie scenes can be joined with smooth "fades" or "wipes" and without abrupt loss of continuity through the use of a kit which contains fading dye and masking tape. The extreme end of the film to be faded is weighted down in a tray, and the end is then lowered slowly into the solution frame by frame. Maximum density is obtained in one minute. Upon removal, the film should be squeegeed with damp absorbent cotton, and immediately rinsed.

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HOLDS: Snapshots in albums, clippings in scrapbooks, shelf paper in place.



BINDS: Lantern slides, repairs model planes, fly rods, broken toys, pictures, tears in movie films.



HOLDS: Jig saw patterns in place, windings to golf clubs, labels to cans, bottles and drawers.



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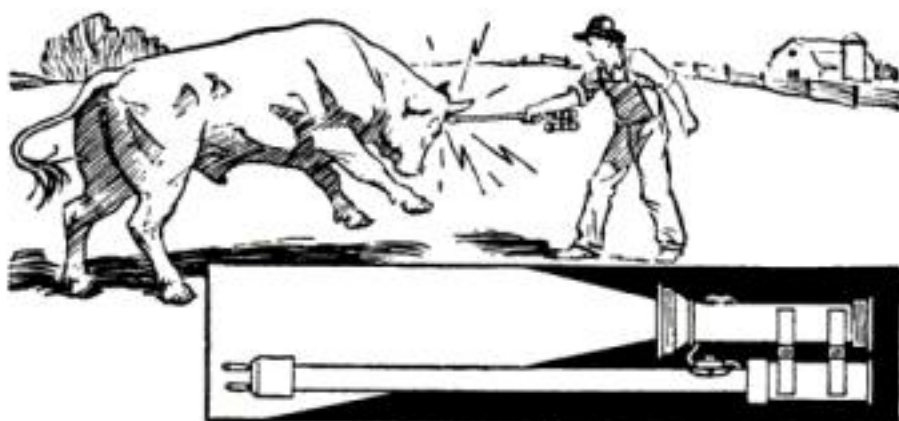
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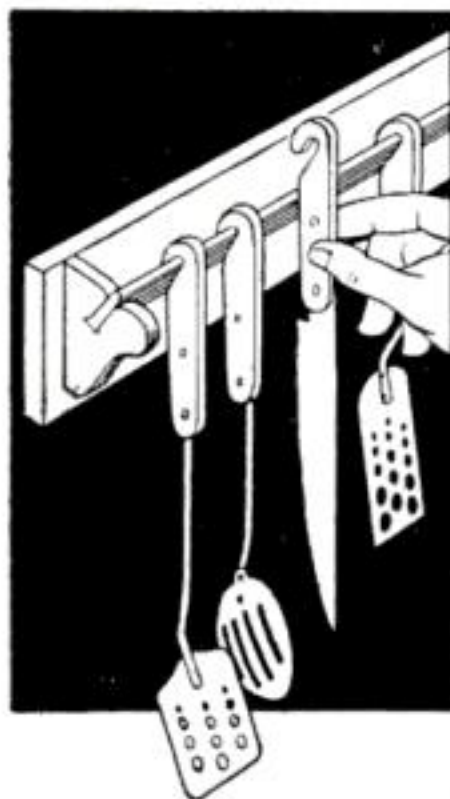
City or Town

With the Inventors

ANY FLASHLIGHT becomes an electric prod, capable of keeping angry bulls and other animals at a respectful distance, with the addition of an attachment devised by Sidney F. Andrus, of Troy Center, Wis. His accessory contains a vibrator



and coil, acting together as a transformer, to turn the feeble power of the flashlight cells into a high-voltage shock of 400 to 2,000 volts at the ends of a pair of prongs. Clamps grip the flashlight to form an electric "ground," while the "live" side of the circuit is provided by an insert behind the bulb and a wire leading to the prod through a hole drilled or punched in the flashlight casing. At night, the flashlight provides illumination for use of the prod, which has its own auxiliary switch. . . . DRAWINGS ALONE do not establish an inventor's right to any particular part of a machine, courts hold, if the text of his patent application fails to describe or claim it. . . . KITCHEN UTENSILS cannot swing and clatter, if their handles are of a slotted design worked out by two Connecti-



cut inventors. The slots engage a handy rack of corresponding form, inclined at the same angle of about 30 degrees from the vertical. Objects hung on the rack cannot help being spaced neatly and accessibly, since it is impossible to hang one on top of another. Similar handles and racks are proposed for workshop tools and

other household implements. The design of the handles, the inventors maintain, is the first of its special kind that does not offer sharp edges or otherwise inconvenience the

(Continued on page 235)

Get a Genuine GILBERT CHEMISTRY SET

The Kind Boys
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Big Awards With

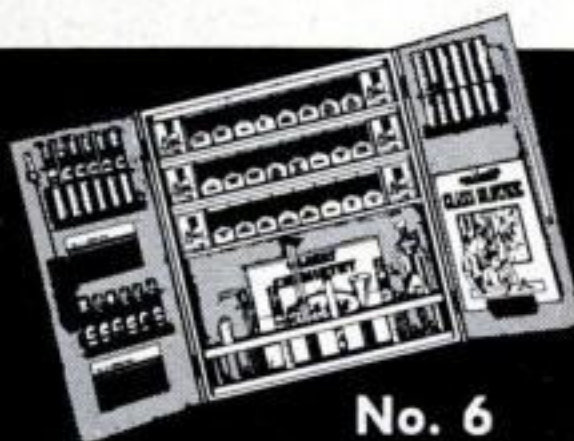
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FOR POLISHING,
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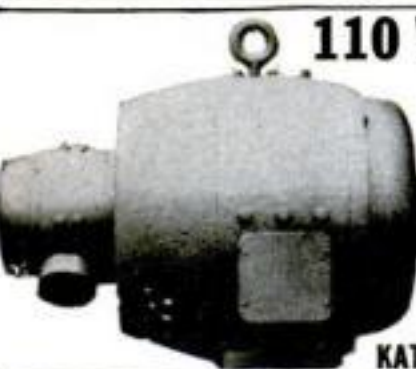
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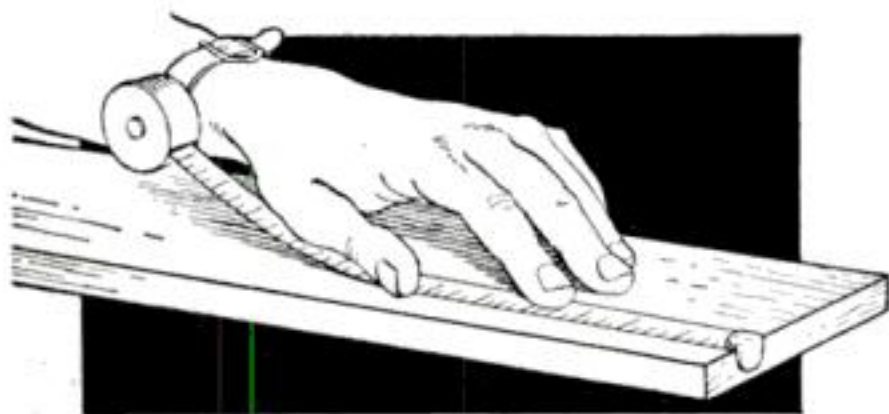
(Continued from page 232)

user. . . ANY SINGLE PART may break without imperiling the occupant, in a safety seat designed for workers in high places by John A. Hoyt, of Glenview, Ill. Resembling a boatswain's chair, his device provides a comfortable perch aloft so that the user can concentrate upon

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where hit-or-miss methods might otherwise offer a tempting short cut. . . TO GUARD THE FRESHNESS of coffee and other products that deteriorate upon exposure to the air, an in-

(Continued on page 236)



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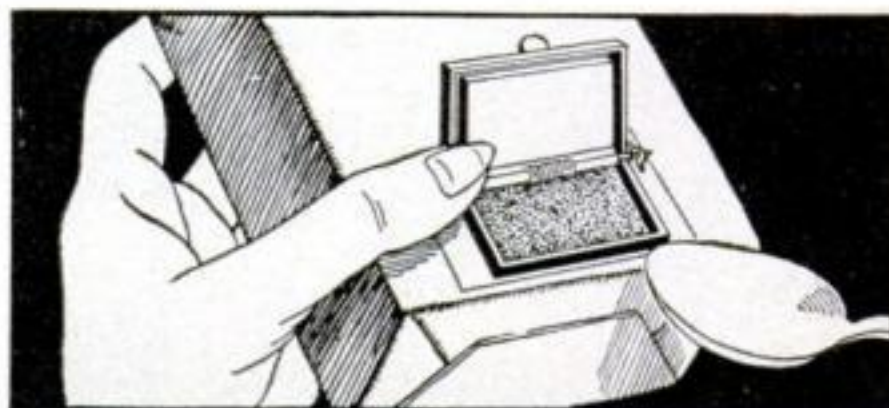
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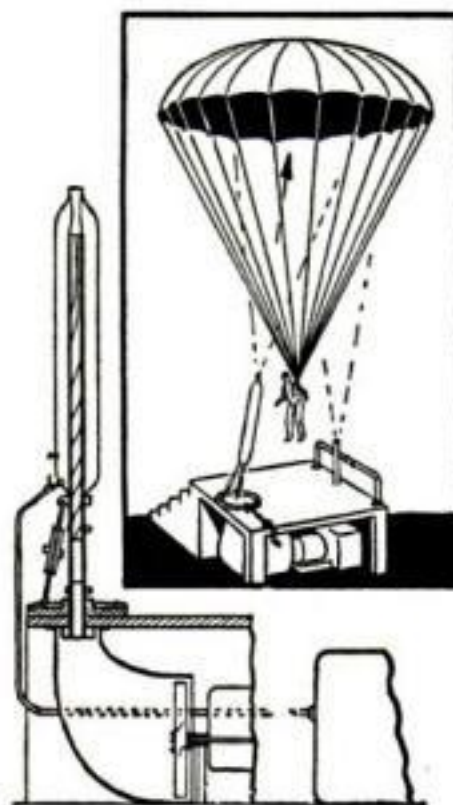
FREE

(Continued from page 235)

expensive container has been designed by Morris Landesman, of Brookline, Mass. At one side of a sealed paper carton, he provides a window with a hinged cover, which is raised as shown to remove enough for a serving. When the cover is released, a spring



snaps it back into place, to provide an airtight closure. As packaged, the window cover is held in place by a strip, dated if desired, which is broken by the customer. Once the package is opened, the small exposed area and quick-acting cover hinder entrance of air while the coffee is being used up.... TRAINING PARACHUTE TROOPS by starting them up, instead of down, is proposed as a way to accustom them gradually to the sensations of jumping. Using newly patented apparatus, a novice stands upon a ground platform and dons a parachute, which is inflated by a jet of air from a small standpipe. A longer standpipe, movable in any direction to suit wind conditions, then delivers an air blast that catapults the airman



to any predetermined height. From the air, he sails freely back to earth, without restraint of guide cables. Progressing to higher and higher jumps, he gains confidence in his equipment, and is ready for full-fledged leaps from a plane. The inventor of the training device estimates that a maximum height of more than 200 feet is attainable,

using a 100-horsepower airplane motor, a blower of wind-tunnel type, and a Venturi-tube jet which would restrain the girth of the column of air discharged upward. . . .

(Continued on page 239)

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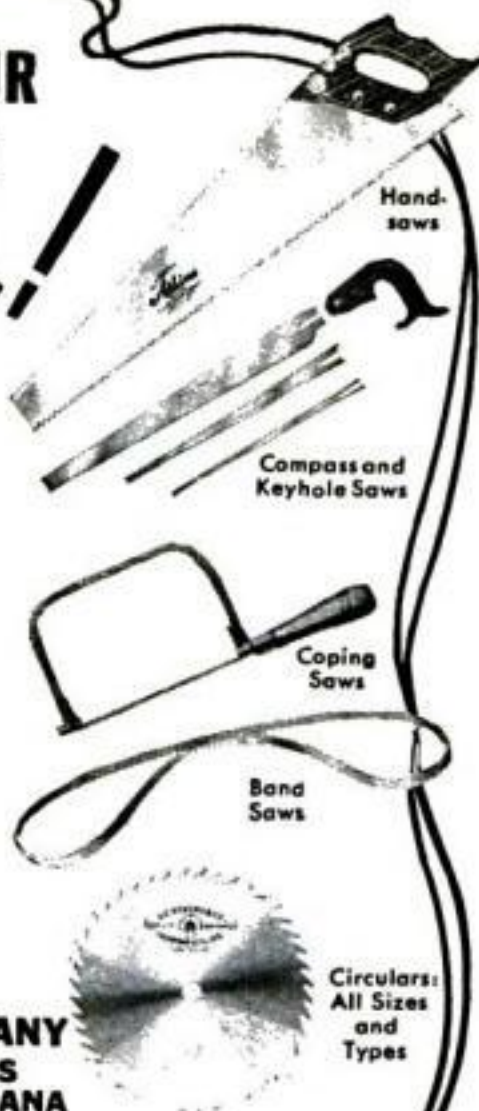
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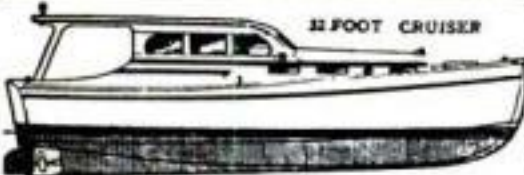


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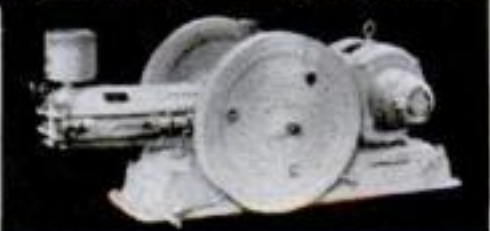
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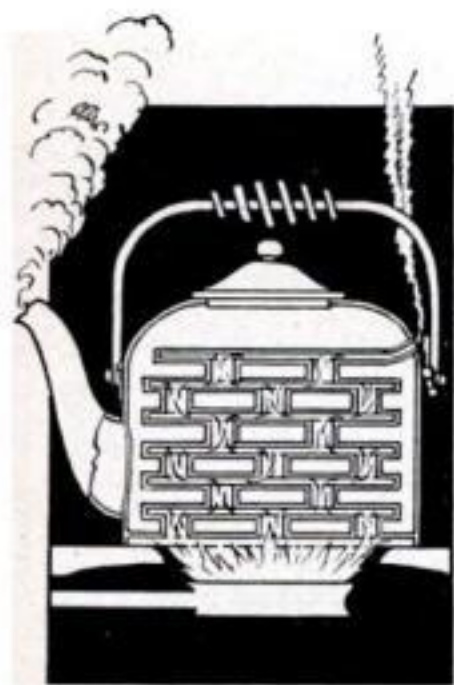
(Continued from page 236)

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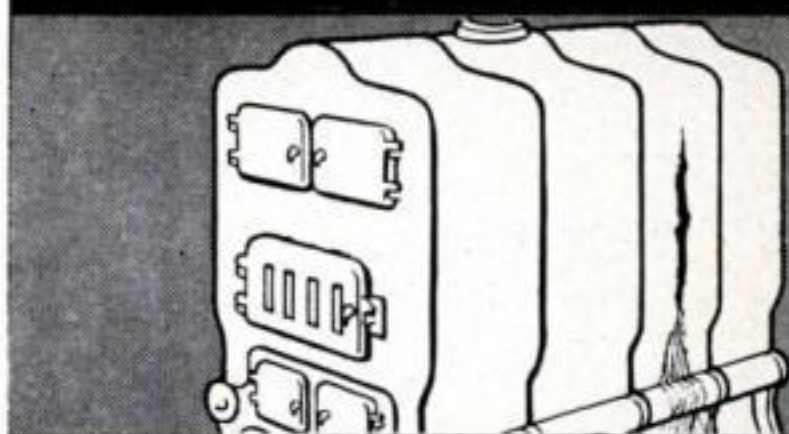
tension of their springs by piston rods in contact with a fixed, eccentric cam, as shown in the illustration. . . . BY PATTERNING a teakettle after a fire-tube boiler, Alfred Mazer, of Newark, Ohio, enables a housewife to bring water to a boil in a fraction of the usual time. The utensil also

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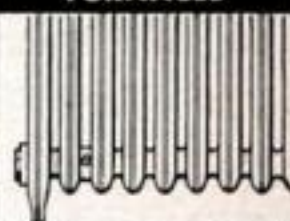
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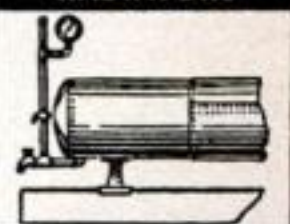
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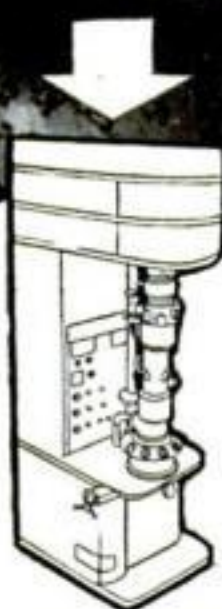
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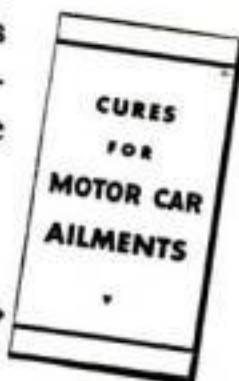


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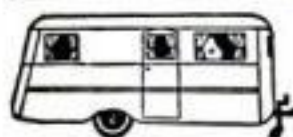
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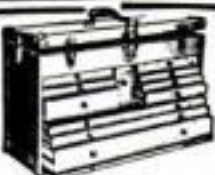
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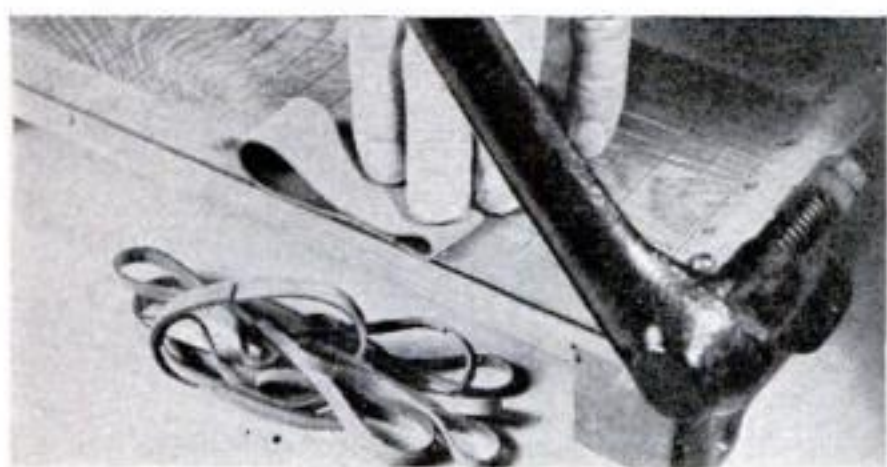
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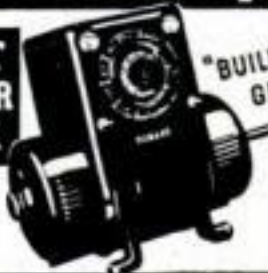
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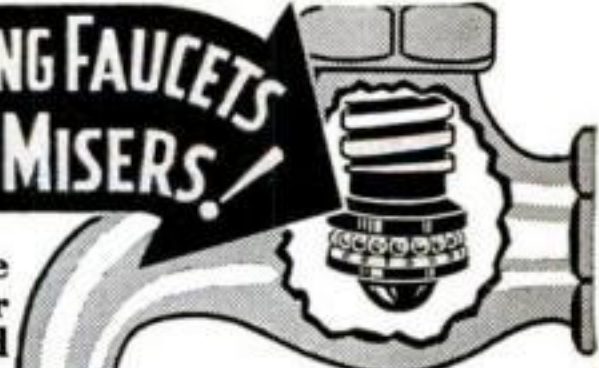
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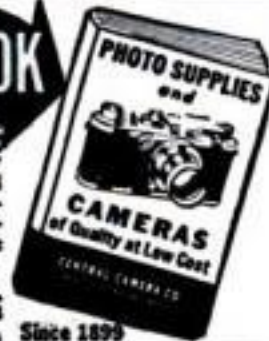
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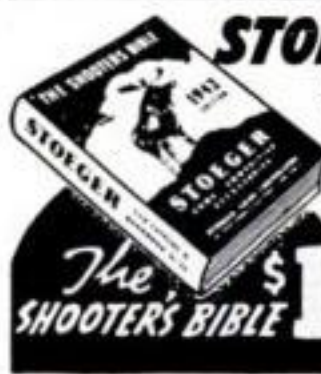


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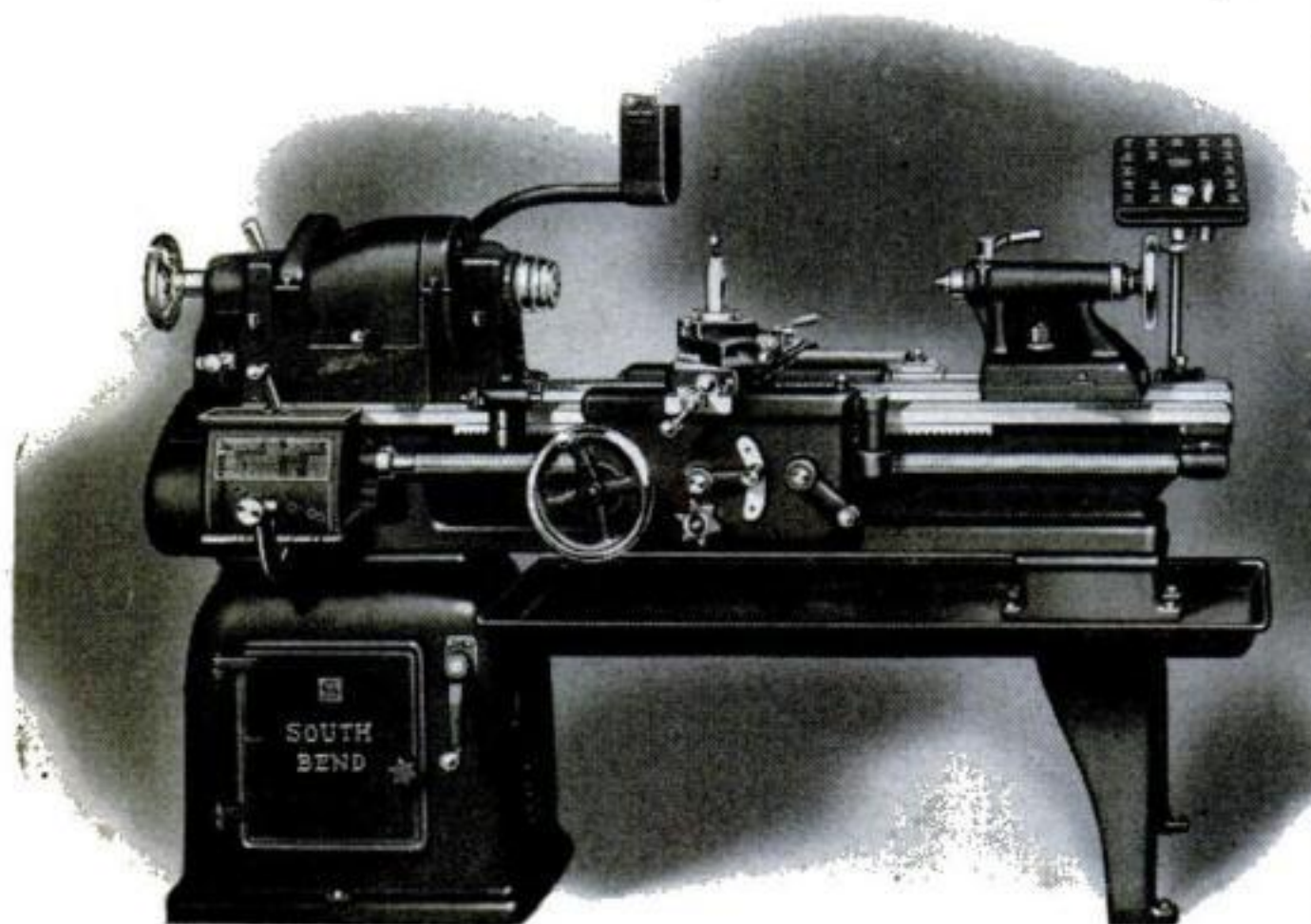
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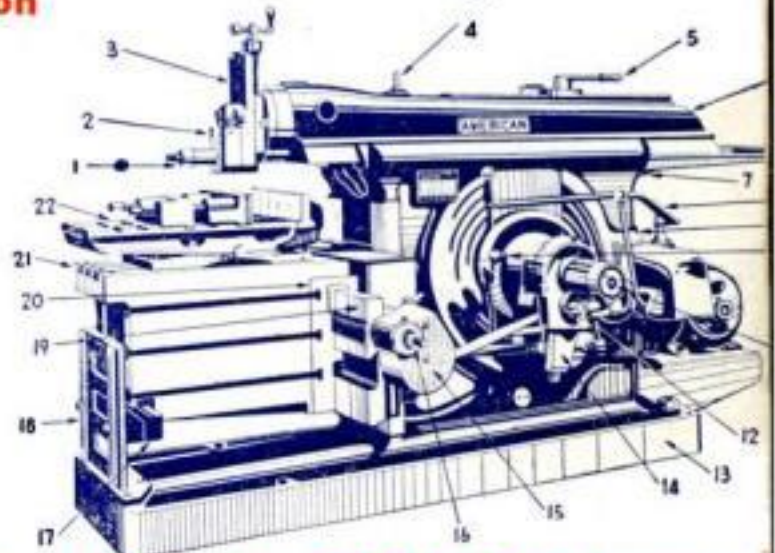
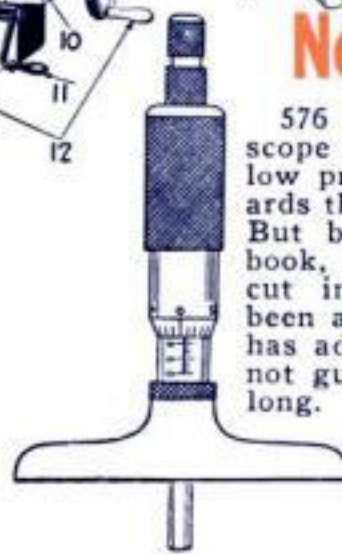
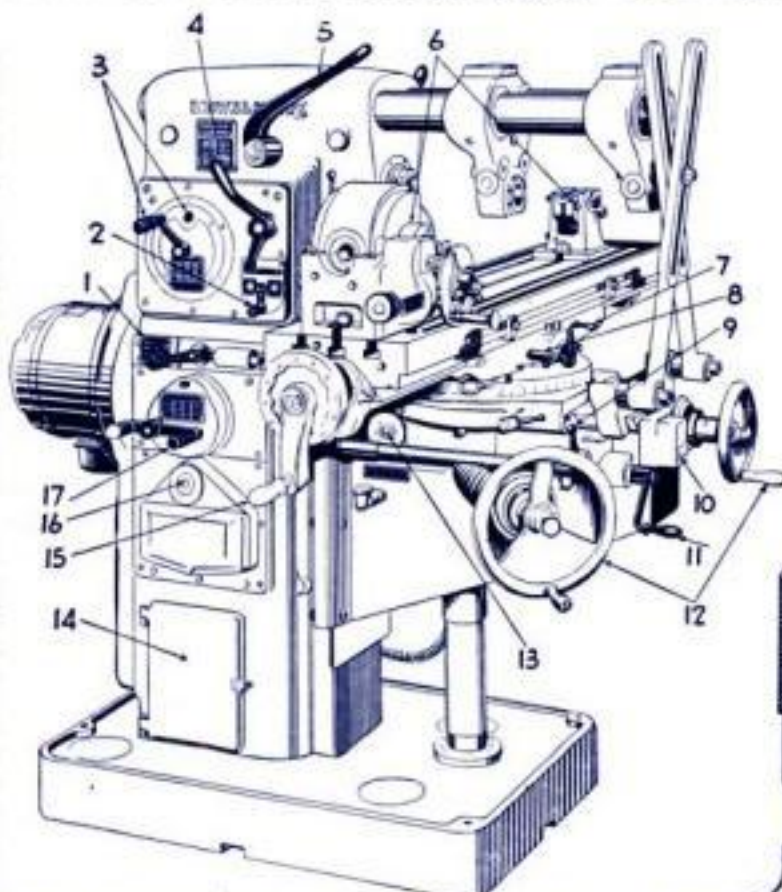
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